PB83-197673

Implementation and Analysis of Hydrocarbon Grab Samples from Cleveland and Cincinnati 1981 Ozone Monitoring Study

Battelle Columbus Labs., OH

Prepared for

Environmental Protection Agency
Chicago, IL

Aug 82

U.S. Department of Commerce
National Technical Information Service
NTIS

United States
Environmental Protection
Agency
Region 5

Environmental Monitoring Branch
230 South Dearborn Street
Chicago, Illinois 60604

EPA-905/4-82-001
September 1982

EPA

Implementation and Analysis of Hydrocarbon Grab Samples from Cleveland and Cincinnati 1981 Ozone Monitoring Study

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Contract No. 68-02-3572
Battele's Columbus Laboratories
Columbus, Ohio 43201

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

FINAL REPORT

on

IMPLEMENTATION AND ANALYSIS OF HYDROCARBON GRAB SAMPLES FROM CLEVELAND AND CINCINNATI 1981 OZONE MONITORING STUDY

Contract No. 68-02-3572

Battelle's Columbus Laboratories
Columbus, Ohio 43201

by

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TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-905/4-82-001	2.
3. RECIPIENT'S ACCESSION NO. PB83 197673	
4. TITLE AND SUBTITLE: Implementation and Analysis of Hydrocarbon Grab Samples from Cleveland and Cincinnati 1981 Ozone Monitoring Study	5. REPORT DATE: August 1982
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S): Michael Holdren, Chester Spicer, Phillip Sticksel, Kevin Nepsund, Gerald Ward, and Richard Smith	8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Battelle's Columbus Laboratories, Columbus, Ohio 43201	10. PROGRAM ELEMENT NO.
	11. CONTRACT/GRANT NO. 68-02-3572
12. SPONSORING AGENCY NAME AND ADDRESS: U.S. Environmental Protection Agency, Region V, 536 S. Clark Street, Chicago, IL 60605	13. TYPE OF REPORT AND PERIOD COVERED: Final
	14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

EPA Project Officer: Stephen K. Goranson (312) 886-6229

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An extensive quality control/quality assurance program was maintained throughout the study. In addition, Battelle cooperated with the U. S. Environmental Protection Agency, Research Triangle Park, NC in conducting an external Q.C. audit of Battelle's analytical methods. The audit showed that Battelle's analyses compared very favorably with EPA results.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
	Monitoring	

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)* Unclassified	21. NO. OF PAGES
	20. SECURITY CLASS *(This page)* Unclassified	22. PRICE

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

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SECTION 1

INTRODUCTION

The Clean Air Act Amendments of 1977 require that states submit State Implementation Plans (SIP's) for attaining ambient air standards for criteria air pollutants by specific dates. In order to attain the ozone ambient standard of 0.12 ppm (one hour average, not to be exceeded more than once a year) precursor control strategies for volatile organic compounds (VOC) must be implemented.

The states are permitted to use any of several analytical techniques to calculate to VOC reductions needed to attain the ambient ozone standard. The more sophisticated of these techniques require consideration of background ozone concentrations and ozone transport.

The empirical kinetic modeling approach (EKMA) is the technique being used in Ohio in determining the necessary VOC reduction and in testing the strategies for attainment of the ozone standard. Use of the EKMA model requires information about the morning ratio of non-methane hydrocarbons to nitrogen oxides ($NMHC/NO_x$) on days of high ozone.

In order to complete development of the 1982 State Implementation Plans for Ozone, the State of Ohio must collect additional non-methane organic compound (NMOC) data at two sites in the vicinity of Cleveland and two sites in Cincinnati. To cross-check the continuous NMOC results and to obtain additional information on hydrocarbon species and reactivity, additional integrated samples will be collected at each site and analyzed for detailed C_2 to C_{10} hydrocarbons.

PROJECT OBJECTIVE

In order to fulfill part of these requirements, Region V of the U. S. EPA, in cooperation with the State of Ohio, issued a contract to Battelle to provide the detailed C_2 to C_{10} hydrocarbon data. Specifically the proposed research contract required these measurements to be made by Battelle at four urban sites, two in Cincinnati and two in Cleveland. At these four locations, 6-9 am integrated bag samples were collected daily and transferred to specially treated aluminum cylinders. On EPA specified days these canisters were then shipped to Battelle, Columbus Laboratories, for analysis. A total of 60 samples was to be analyzed during the course of the field project. This report includes those results along with a description of the sampling and analytical techniques employed in that effort.

SECTION 2

SUMMARY

Non-methane organic carbon (NMOC) concentrations were determined by Battelle during a field study at four urban sites, two in Cincinnati and two in Cleveland. Using special gas chromatographic techniques, 67 samples were analyzed during the field program (July 16, 1981 to September 15, 1981). These techniques permitted the identification and quantification of 36 major hydrocarbon species. The concentration of these identified compounds represented from 60 to 90 percent of the total NMOC burden. The NMOC values obtained by the speciation method were also compared to those values found by continuous methods in operation at the field sites. Linear regression analyses were performed on the data and correlation coefficients from .75 to .92 were found when comparing methods.

An extensive quality control/quality assurance program was maintained throughout the study. In addition to many in-house Q.C./Q.A. activities, Battelle cooperated with EPA/RTP in conducting an external Q.C. audit of Battelle's analytical methods. The audit showed that Battelle's analyses compared very favorably with EPA/RTP results.

SECTION 3

EXPERIMENTAL

SAMPLING METHODOLOGY

The sampling portion of the program consisted of collecting three-hour integrated air samples in Teflon® bags and then transferring the contents into specially treated aluminum cylinders for shipment and analysis. To accomplish this task a sampling system was fabricated for each of the four sites and was laboratory tested prior to field use. Once the laboratory testing was completed, these sampling systems were transported to the field sites and an operator training program was initiated to assure that correct collection, transfer and shipment procedures be established for the EPA field operators. A description of these aspects is given in the following sub-sections. The Quality Control/Quality Assurance procedures during this phase of the program is detailed in Section 5.

Sampling System Preparation

The sampling system included three component parts:

(1) Pumping station
(2) Teflon® bag
(3) Aluminum cylinder

Each component part was separately fabricated, tested, and then connected together to form one complete sampling station. Each sampling station was laboratory tested by connecting each completed unit to a zero air source (Aadco Clean Air Generator) and simulating actual field sampling procedures to collect a sample. This included filling the bag over a three hour period and then immediately transferring the contents to an aluminum cylinder. A non-methane hydrocarbon level of less than 30 ppb C was found in all tested units (data in QC/QA section).

Pumping Station--

A diagram of the pumping station is shown in Figure 1. A Metal Bellows Model MB-41 pump provided adequate air flow through the sampling system. A tee arrangement also shown in Figure 1 permitted a fraction (<1 percent) of this total flow to be diverted to the Teflon® bag during the sample collection period. By adjusting the regulating valve (Whitey #B-2RS4) at the tee exit, a fixed flow through the 1/16 inch O.D. restrictor could be established. Laboratory tests demonstrated that this restricted flow (50 cc/min) remained at a constant level (± 5 percent) during 48 hours of continuous pump operation. A setting of 50 cc/min was subsequently used during the field program and provided sufficient flow to pass into the bag during the three hour collection period. This flow setting was checked each day by the field operators and appropriately adjusted if necessary by opening or closing the metering valve.

Several advantages were apparent in employing the above flow design. First of all by not severely restricting the total flow capacity of the pump, the unit was better able to operate at cooler temperatures thus minimizing hydrocarbon emissions from the potentially "hot" pump surfaces. Likewise by allowing less than 1 percent of the pump effluent into the bag a smaller fraction of any contaminants produced by the pump station would affect the sample integrity.

A five micron filter placed in line ahead of the pump was used to remove particulate material. This was necessary both to protect the pump and keep particles from plugging the 1/16 inch restrictor line. The use of check valves in the design prevented laboratory air from entering the sampling system when the unit was not in use.

Teflon® Bags--

Five mil Teflon® bags were fabricated at Battelle using a modified Tedlar® bag sealer (Vertrod, Inc.). Each bag was 2 ft by 2 ft and contained a Swaglock stainless steel female quick connect as a sampling port. The quick connect was sealed to the bag by a Viton o-ring/Teflon® insert. A total of twelve Teflon® bags were constructed for this study. This permitted each site to have two backup bags. When not in use, these bags were stored in 5 mil garbage bags for protection from accidental puncture.

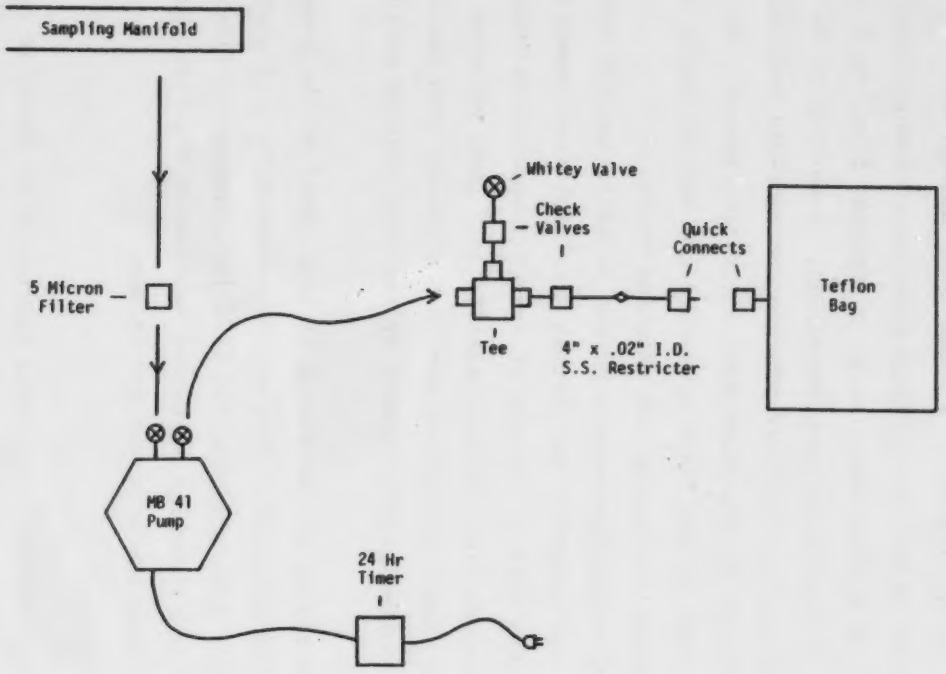


FIGURE 1. DIAGRAM OF PUMPING STATION APPARATUS

Past experience has shown that Tedlar® bags are easier to seal and considerably more durable than the Teflon® bags, and initial plans called for their employment in this program. However laboratory tests conducted prior to this contract award had shown several contaminant peaks eluting from the Tedlar®. Other researchers have also noted these contaminants.(1) In our preliminary investigation these contaminants contributed from 50 to 150 ppb C when simulated three hour integrated samples were collected. Although these peaks could be subtracted from the total non-methane organic burden, their elution times masked several known hydrocarbon peaks. As a result, a decision was made to incorporate the more fragile Teflon® bags into our sampling scheme. Daily field checks over the course of the program turned up three bags which developed leaks and had to be replaced. These results were much better than expected and were probably due to the fact that the bags were well protected and minimally handled during the study.

Aluminum Cylinders--

Specially deactivated aluminum cylinders obtained from the Airco Company were used to store the samples during transfer and shipment operations. A stainless steel tee coupled to two stainless steel valves (Nupro 4H) was designed at Battelle and replaced the valve system that originally came with each cylinder. Figure 2 depicts one of these modified cylinders. Twenty cylinders were utilized in the sampling program. Each canister was pressurized with hydrocarbon-free air and leak tested. Following a five day storage period each canister was analyzed for non-methane organic compounds using gas chromatographic speciation techniques. In all cases less than 10 ppb C background material was found.

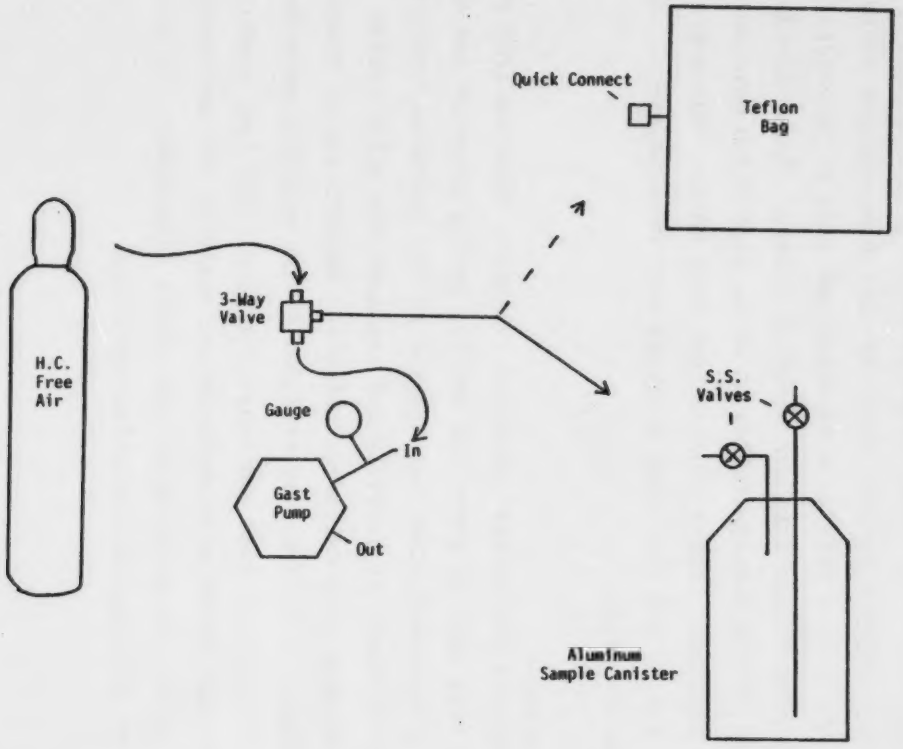


FIGURE 2. DIAGRAM OF SAMPLING BAG AND CANISTER PREPARATION APPARATUS

Sampling System Field Operation

Following the sampling train fabrication and laboratory check out procedures, Battelle personnel transported the sampling units to Cincinnati and Cleveland and conducted a training session at each city for all site operators. Afterward the sampling units were set-up at the EPA designated sites. Each site was provided with the following equipment:

(1) 24 hour timer
(2) stainless steel Metal Bellows (MB-41) pump
(3) flow restrictor assembly
(4) three Teflon® bags
(5) five aluminum sample cylinders with mailing tubes
(6) two ultra zero air cylinders with regulator
(7) Gast carbon vane pump
(8) gauge assembly/flowmeter
(9) brass three-way ball valve
(10) assorted tubing
(11) prepaid address labels.

Both the Norwood and University Campus sites in Cincinnati contained glass sampling manifolds with available sampling ports. The two sites in Cleveland (St. Vincent and Rickoff) however did not have glass manifold systems. In order to provide a temporary sampling manifold, a Teflon® line was run up near the existing air sampling lines and was connected to an inverted glass funnel (to keep rain from entering the line). Operating in this fashion permitted adequate sample flow to the sampling unit and did not result in water condensation problems within the Teflon® line of the pumping system.

Although each site operator was involved in the initial training session, a written set of instructions for collecting and shipping a sample was provided as a precautionary measure. These instructions were as follows:

HYDROCARBON SAMPLING PROCEDURES FOR OHIO EPA 1981 MONITORING STUDY

I. SAMPLING BAG PREPARATION

(1) Completely evacuate the bag using the Gast carbon vane vacuum pump.

(2) Fill the bag with zero air from cylinder. (Set cylinder regulator gage to ∿5 psig when filling bags). Do not fill bags completely full since this will cause the seams to burst (∿1/2 full is adequate).

(3) Repeat steps 1 and 2 three times in order to sufficiently remove the previous day's sample. A total of four zero air fillings will have been made.

(4) Place a slight amount of weight (small book) on top of the partially filled bag and set the bag aside for several hours to check for leakage. If deflation of the bag does occur, replace it with the spare bag and repeat steps 1, 2, and 3. Notify Battelle so that additional bags may be sent.

(5) Completely evacuate the leak-free bag with the Gast pump and then add just enough zero air to relieve the vacuum stress on the bag. The bag is now ready for sample collection.

II. CANISTER PREPARATION

(1) All cans shipped/delivered by Battelle will be filled to 15 psig with zero air and will have been leak tested. Cans used by Ohio EPA personnel in the field will contain ambient air. To prepare a canister for sampling connect a gage assembly to the side valve on the can and the quick connect fitting to the top valve fitting.

(2) Immediately prior (several minutes) to filling the can with the day's sample, evacuate canister to ∿26" (gage) using the Gast vacuum pump apparatus (be sure to open can valves).

(3) Fill the can to a slight positive pressure with cylinder zero air (cylinder set at ∿5 psig).

(4) Repeat steps 2 and 3 three times if the can contained ambient air.

(5) With the canister evacuated to ∿26", shut off valves on canister. Can is now ready to receive contents of sample bag.

III. SAMPLE COLLECTION

(1) Make sure the sampling train is correctly hooked to the sampling manifold.

(2) Turn on the bellows sampling pump momentarily to flush out system. Set the flow at the outlet of the 1/16" restrictor to 50 ml/min. This is measured by temporarily hooking up the supplied rotameter. Turn the pump off.

(3) Connect the bag to outlet of the 1/16" line restrictor.

(4) Check that the timer is set to start sampling at 0600 hour and to stop sampling at 0900 hours.

(5) Record bag number and sampling date in the log book.

IV. TRANSFER OF SAMPLE FROM BAG TO CANISTER

(1) After bag filling has been completed, disconnect bag from the 1/16" line restrictor.

(2) Connect the bag with the short connecting line to the top quick connect on the recently evacuated canister. Open the top valve to draw sample from the bag into the can until the attached canister gage reads zero (be sure to open side valve). Close the top can valve.

(3) Disconnect the sampling train at the bellows pump's inlet and outlet (at the quick connect).

(4) Disconnect the bag from the canister (keep the attached bag line connected to the bag) and insert the quick connect onto the bellows pump inlet.

(5) Attach the additional quick connect line to the pump outlet and turn on the pump to flush out the pump lines (5 seconds). Attach the pump outlet line to the side canister quick connect, open the valve, and fill the can to 15 psig as measured with the gauge attached to the side valve on the canister.

(6) Close both valves on the can.

(7) Remove the gauge assembly and the bag apparatus. Put on the brass plugs that originally came with canisters and tighten.

(8) Record the canister number and gauge pressure in the log book. Also record ambient temperature and barometric pressure if available.

V. SHIPPING

(1) Place the aluminum can (with attached brass plugs) into shipping carton.

(2) Enclose the filled-in sampling form.

(3) Make sure the carton has a business reply label (postage paid by Battelle) and sufficient packing. Seal the container with glass tape.

(4) Send by first-class mail.

VI. MISCELLANEOUS NOTES

(1) Make sure that the operator logs in on a daily basis, completing all the requested information.

(2) Be sure to shut off the zero air cylinder when not in use. This gas should be conserved since it is a special order, low hydrocarbon zero air.

(3) Be sure to enclose a sampling form with the can when shipping.

(4) Try to use the same bag for each daily collection. After the daily 6-9 a.m. sample has been transferred to the can, fill that bag up and leak test it, etc. Once the operator has completed the leak test he should then go to the SAMPLING BAG PREPARATION procedures.

In addition to the training session and written instructions, phone numbers of key Battelle staff were left at each site. Furthermore during the study a Battelle staff member audited the two Cleveland sites to assure that the correct sampling protocol was being followed. The result of this audit revealed no problems had occurred with the performance of the sampling systems and likewise showed that correct operating procedures were being adhered to. Budget constraints for travel prohibited a field audit of the Cincinnati sites. However, phone conversations with the site personnel there confirmed that the sampling system was also performing very well. Likewise, all sites were provided with log books in which the operators were requested to sign in, record the bag and cylinder numbers used that day and then note any comments concerning the operations. This information provided additional support that the field operations had run smoothly.

In order to link the field operations with analytical operations at Battelle, the site operator was further required to supply a sampling form (Figure 3) along with each shipped cylinder. Once received at Battelle each form was signed, transferred to a Battelle log book, and later verified for correct collection date, etc. This form likewise provided valuable information concerning average times from sample collection to sample receipt and analysis. An average of three days in transit occurred during this program when shipping by first class mail. An additional one day on the average was needed before the analysis was completed.

OHIO EPA 1981 MONITORING STUDY
SAMPLING FORM

Site Location:_____

Operator:_____

Date of Sample Collection:_____

Cylinder Number:_____

Cylinder Pressure:_____

Bag Number:_____

Room Temperature:_____ Barometric Pressure:_____

Air Quality Measurements (If Available)

Peak Ozone_____

Peak NO_x_____

Comments:

FIGURE 3. OHIO EPA SAMPLING FORM

ANALYTICAL METHODOLOGY

Instrumentation

C_2 to C_{10} hydrocarbon concentrations in the aluminum cylinders were determined with two gas chromatographs. Each instrument was modified to include a sampling valve (Carle Instruments) coupled to a 0.2 cm I.D. by 15 cm long stainless steel U-tube (freeze-out trap) filled with 60/80 mesh glass beads. This freeze-out system permitted the cryogenic enrichment of up to 500 cc of sample. C_2 to C_5 hydrocarbon analyses were achieved with a Varian 1200 gas chromatograph. This unit was operated isothermally at 35 C and employed a 0.2 cm I.D. by 3 meter Teflon® column filled with 60/80 mesh phenylisocyanate/Porasil C material. C_5 through C_{10} hydrocarbons were determined with a Hewlett Packard 5711 gas chromatograph. A 50 meter S.E.-30 fused silica wall coated column (Hewlett Packard) permitted the separation needed for these analyses. Furthermore the use of subambient temperature programming from -50 to 150 C at 8 degrees per minute provided excellent resolution, stable baselines and a reasonable turn around of analyses (1 hr/sample). Figures 4 and 5 illustrate typical chromatograms obtained during the analysis portion of the program. This particular sample was obtained from the University Campus Site at Cincinnati on August 24, 1981. Table 1 provides a listing of the major species identified in this sample.

Data from the gas chromatographs were processed by a Hewlett Packard 3388-A dual channel integrator. This computerized system provided a chromatographic plot and individual hydrocarbon identification and quantitation immediately following each G.C. run. However due to the complexity of the samples, each run was checked afterward for correct peak assignment and quantitation values.

A dynamic dilution system from Columbia Scientific Industries was employed to fabricate the dilution/calibration mixtures. An Aadco "zero air" instrument supplied the necessary dilution air for the CSI calibrator.

Sample Analysis Procedure

The normal carrier gas flow system in each gas chromatograph was routed through a heated six port valve. Figure 6 shows a schematic of the

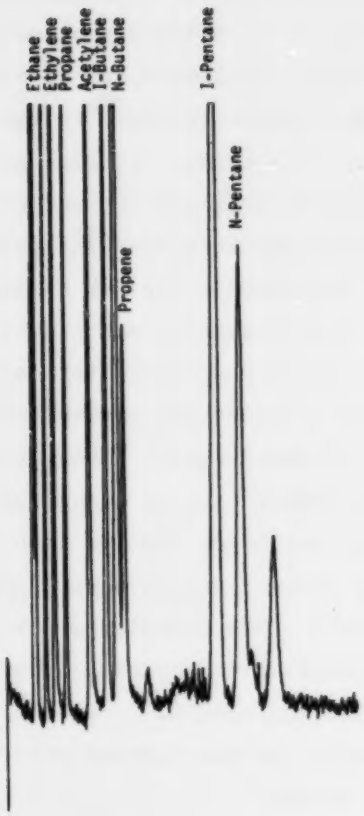


FIGURE 4. LIGHT HYDROCARBON CHROMATOGRAM (C_2 to C_5) FROM THE UNIVERSITY CAMPUS SITE, CINCINNATI, OHIO. COLLECTED 8/24/81

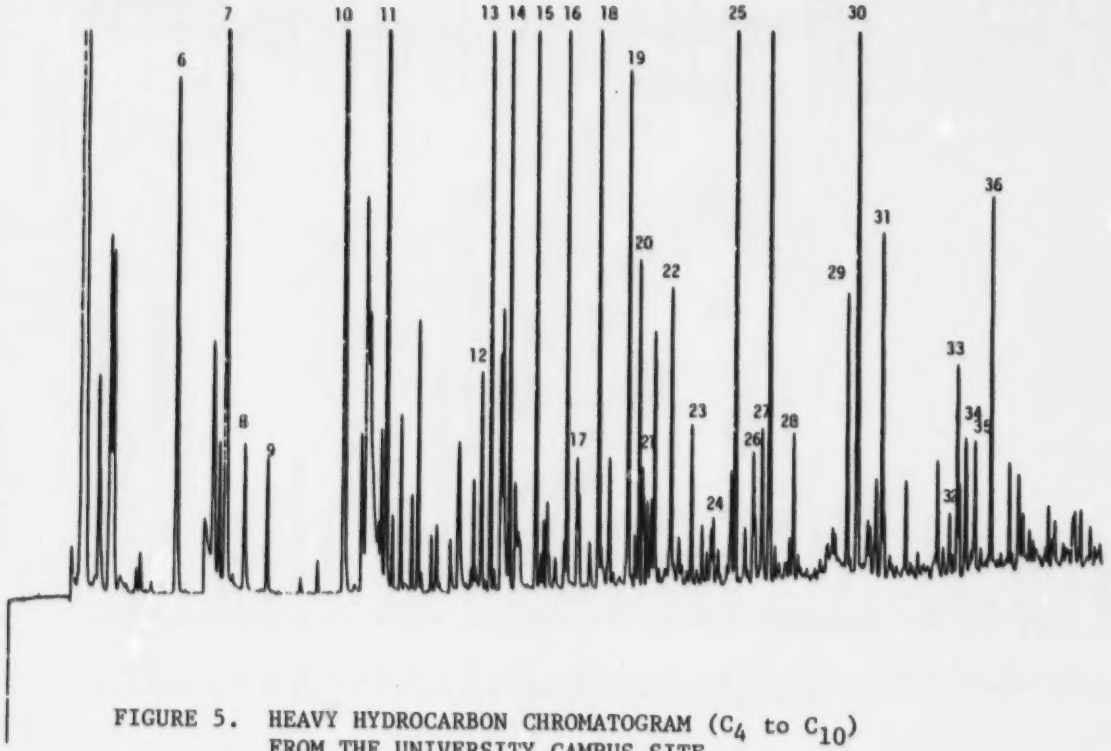
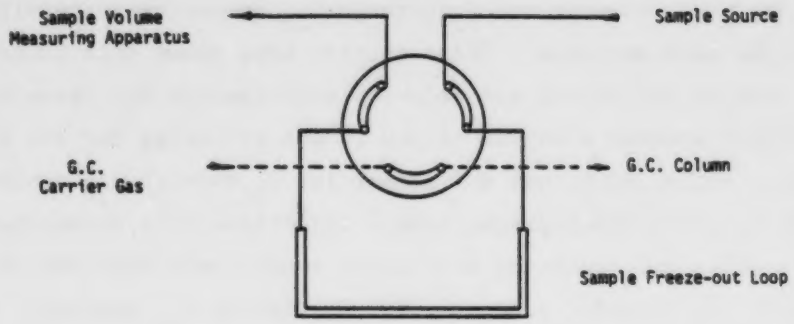


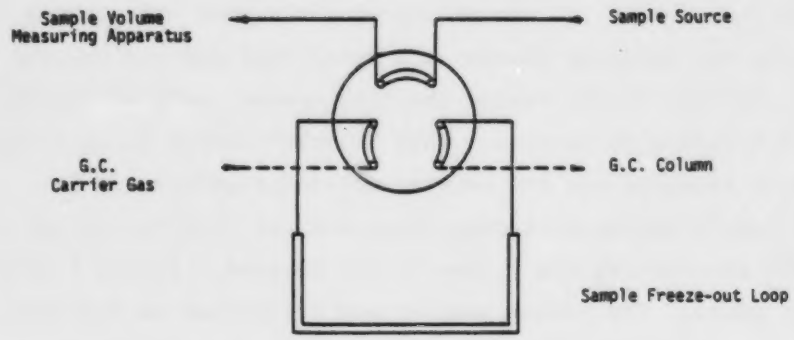
FIGURE 5. HEAVY HYDROCARBON CHROMATOGRAM (C_4 to C_{10})
FROM THE UNIVERSITY CAMPUS SITE,
CINCINNATI, OHIO. COLLECTED 8/24/81

TABLE 1. OHIO EPA, 1981
SAMPLE I.D.
UNIVERSITY CAMPUS SITE, 8/24/81

	Hydrocarbon	ppb
1.	Ethane	43.2
2.	Ethylene	113.5
3.	Acetylene	44.1
4.	Propane	23.8
5.	Propene	29.8
6.	I-Butane	44.3
7.	N-Butane	115.9
8.	T-2-Butene	9.7
9.	C-2-Butene	6.4
10.	I-Pentane	137.3
11.	N-Pentane	68.6
12.	2,3-Dimethylbutane	11.1
13.	2-Methylpentane	42.8
14.	3-Methylpentane	28.0
15.	N-Hexane	33.7
16.	Methylcyclopentane	27.2
17.	2,4-Dimethylpentane	4.2
18.	Benzene	35.1
19.	2-Methylhexane	25.6
20.	3-Methylhexane	14.6
21.	2,2,4-Trimethylpentane	5.2
22.	N-Heptane	15.1
23.	Ethylcyclopentane	7.7
24.	2,4-Dimethylhexane	3.1
25.	Toluene	73.5
26.	2-Methylheptane	6.7
27.	3-Methylheptane	9.3
28.	N-Octane	6.9
29.	Ethylbenzene	12.5
30.	M+P-Xylene	42.4
31.	O-Xylene	15.3
32.	N-Propylbenzene	3.6
33.	P-Ethyltoluene	9.5
34.	1,3,5-Trimethylbenzene	7.8
35.	O-Ethyltoluene	7.9
36.	1,2,4-Trimethylbenzene	17.2
	Identified NMOC	1108
	Unidentified NMOC	762
	Total NMOC	1870



1) FILL POSITION



2) INJECTION POSITION

FIGURE 6. SCHEMATIC OF THE CRYOGENIC VALVE-TRAP SYSTEM

valve/trap system used for the cryogenic operations. Sampling was initiated by connecting the aluminum cylinder to the inlet side of the valve and flushing out the trap and sample lines. After approximately 100 cc had passed through the system, the flow was stopped and the trap was immersed into a dewar of liquid argon (-186 C). Once the trap temperature had equilibrated, a measured volume of air was directed through the cooled freeze-out trap. At liquid argon temperatures air and methane were not retained in the trap, however the C_2 through C_{10} hydrocarbons readily condensed on the cold surfaces. (Past studies have shown this procedure to provide 100 percent collection and recovery efficiencies for these species[2,3].) During this field program a volume of 500 cc was collected for the C_2 to C_5 determinations, while 250 cc was sufficient for C_5 through C_{10} analyses. For the C_2 to C_5 gas chromatograph, sample injections were accomplished by switching the valve and replacing the liquid argon dewar with one of hot water to assist the transfer process. For C_5 through C_{10} analyses, the hot water dewar was permanently replaced with an electrical resistance heating design. A chromel-alumel thermocouple wire, beaded and insulated at one end was wrapped around the length of the sample trap. The other end of the wire was connected to a Variac. A second thermocouple wire served as a temperature sensor and was inserted between the metal tube and the wrapped wire. By applying a voltage to the Variac the trap system could be heated from -186 C to 150 C within 20 seconds. This "hotter" sample flush assured complete sample transfer for the heavier molecular weight species.

A sample volume measuring apparatus was constructed and utilized for accurately determining the volume of air sampled. Figure 7 illustrates its component parts. The volume sampled was determined as follows: A container with a known volume was evacuated and the absolute pressure measured with a Wallace-Tiernan pressure gauge. A four-way ball valve controlled the flow of sampled air into the "fixed" volume container (2.84 liters). A known change in pressure within this tank corresponded to a specific volume of air passing through the freeze-out trap and into the container. Knowing the volume, pressure, and temperature of the system, the ideal gas law was used to calculate the number of moles of air sampled. On a volume basis, this converted to the following equation:

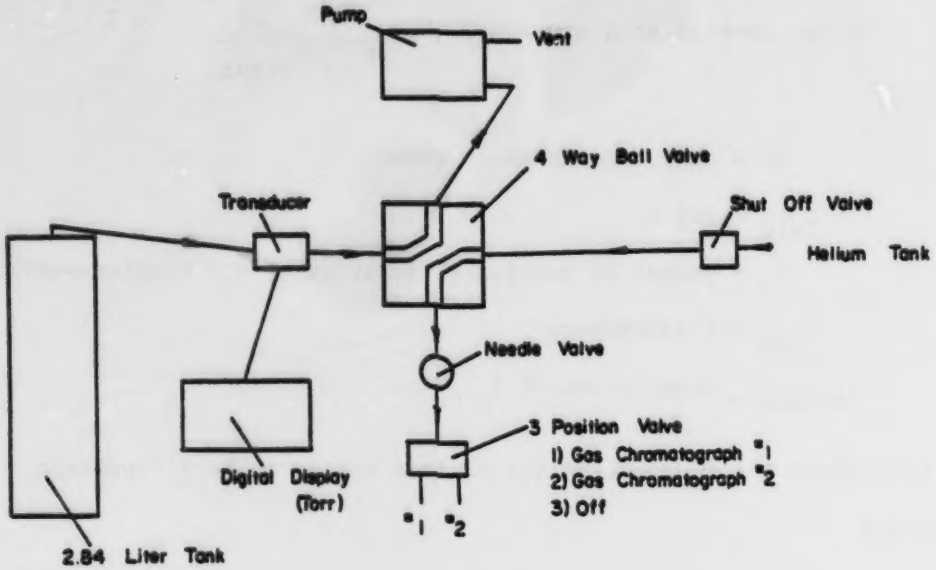


FIGURE 7A. DIAGRAM OF SAMPLE VOLUME APPARATUS IN THE PUMP-DOWN POSITION

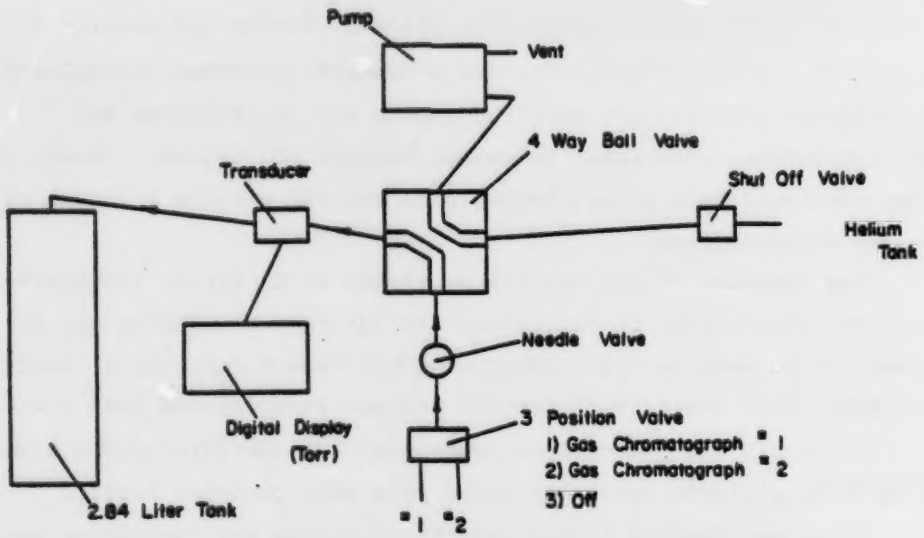


FIGURE 7B. DIAGRAM OF SAMPLE VOLUME APPARATUS IN THE MEASURING POSITION

$$\text{Volume sampled at 1 atm and 25 C} = \frac{\Delta P \; T_{std} \; V_c}{P_{std} \; T_{actual}}$$

where ΔP = change in pressure within V_c

T_{std} = 298 K

V_c = volume of container (measured by H_2O displacement)

P_{std} = 1 atmosphere

T_{actual} = temperature of V_c .

Tests have shown the reproducibility of this system to be $\pm$ 1 percent.

Calibration

Calibration of each gas chromatograph was based upon the response from a "certified" NBS propane standard. For the light hydrocarbon (LHC) gas chromatograph, both multipoint and single point calibration checks were completed with this NBS propane standard directly. For the heavy hydrocarbon (HHC) gas chromatograph, a secondary standard was employed for multipoint and single point calibration checks. During the earlier part of the program, this standard contained n-pentane, n-hexane and toluene. A five component standard was utilized during the latter phase and included isopentane, n-pentane, n-hexane, benzene and toluene. These secondary standards were cross-checked with the NBS propane cylinder on the LHC gas chromatograph.

The response of the analytical system to different hydrocarbon compounds has been tested in our laboratory during past studies and an equivalent F.I.D. response per carbon atom has been found. As a result, the ppbC/area count response of the NBS propane standard was used for quantitation of all the hydrocarbon compounds. Unidentified peaks eluting during the G.C. analysis were also given this same response factor.

Likewise provided by our analytical scheme are isopentane and pentane concentrations from both G.C. instruments. During the study a continual check on the relative comparison of these values was made and appropriate action taken if the concentration between instruments differed by more than $\pm$ 5 percent.

Accuracy

A relative accuracy of ± 20 percent for each identified compound has been estimated from past studies. A quality assurance program conducted last year with EPA-ESRL and Washington State University demonstrated excellent inter-laboratory agreement.[4] In this study selected C_2 to C_9 mixtures at low ppb concentration levels were obtained from EPA. Each lab was required to identify the components and report their concentrations. Correct identification occurred for all the compounds and quantitative amounts agreed to within 10 percent. Similar mixtures from EPA were also obtained during the present study. (These results are given in Section 5.)

Precision

A precision of less than 5 percent was generally found when running replicate standard mixtures (10 ppbC to 5 ppmC) over the course of the study. A precision of less than 5 percent was determined when replicate ambient air samples were compared.

Detection Limit

A detection limit of 1 ppbC was found when using a 250 cc sample (a signal to noise ratio equal to 4/1). Component values below 1 ppbC were not recorded.

SECTION 4

RESULTS

SAMPLING PROGRAM

The sampling portion of the program was in operation from July 10 to September 15, 1981. Figure 8 shows the total number and location of all samples shipped to Battelle during the study. A total of 67 air samples was collected and shipped to Battelle. Thirty samples originated from Cleveland; the remaining 37 samples were obtained from Cincinnati.

During the initial phases of the sampling program, air samples were to be shipped to Battelle's laboratory for analysis on those days having afternoon ozone concentrations at or above 0.10 ppm (i.e. samples would be stored overnight). Early in the study it was recognized that there might not be many days when this ozone level would be exceeded. As a precautionary measure, Ohio EPA officials designated specific days on which the integrated samples would be automatically shipped to Battelle. This procedure did not preclude shipping canisters filled on days exceeding the 0.10 ppm ozone level. However preliminary reports from the field operators have shown that there were no weekdays exceeding the 0.10 ppm ozone level. As a result, the data in Figure 8 reflects the sampling/shipping scheme specified by Ohio EPA.

DATA ANALYSIS

All the sample data has been reduced and is available in Appendix A. Each run was individually analyzed for 36 major hydrocarbon species. The concentration of these identified compounds represented from 60 to 90 percent of the total non-methane organic carbon (NMOC) burden. Eleven of the originally collected samples were reanalyzed as part of the quality assurance effort and are also included in Appendix A. However, discussion of those results are covered in the QA/QC section.

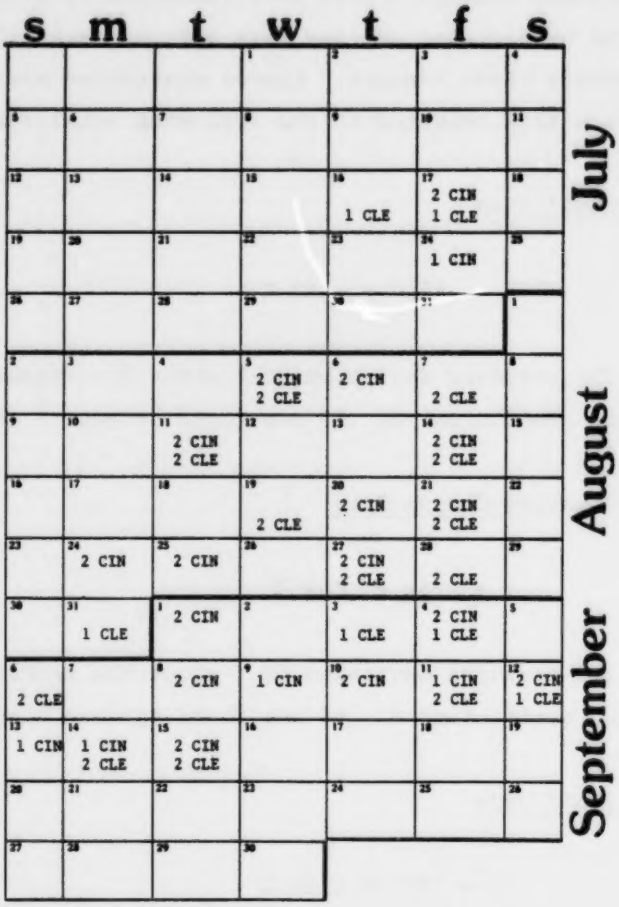


FIGURE 8. THE NUMBER AND LOCATION OF SAMPLES COLLECTED AND SHIPPED TO BATTELLE DURING THE FIELD PROGRAM

The NMOC values obtained by the speciation method were also compared to those values found by continuous methods in operation at the field sites. Table 2 lists these comparisons for the 67 samples collected. The data obtained by the continuous method represents the preliminary values obtained from the 6 to 9 a.m. Saroad data (3 one hour averages). This data has not yet been verified by Ohio EPA.

The non-methane organic carbon data collected by both methods were further compared by plotting the two data sets at each site. Figures 9 through 12 illustrates these results. Linear regression analysis of the plotted data from each site resulted in the following equations*:

At the Norwood Site

$$Y = -85.4 + .813\ X$$

and an estimate of the standard deviation of Y about the regression line is 128.7. A correlation coefficient of .92 was found between X and Y.

At the University-Campus Site

$$Y = -164 + .884\ X$$

and an estimate of the standard deviation of Y about the regression line is 182.4. A correlation coefficient of .87 was found between X and Y.

At the Rickoff Site

$$Y = -280 + 1.30\ X$$

and an estimate of the standard deviation of Y about the regression line is 210.5. A correlation coefficient of .89 was found between X and Y.

---

* (Battelle's data = X, continuous data = Y.)

TABLE 2. COMPARISON OF NON-METHANE ORGANIC CARBON DATA
(Battelle's GC method vs continuous method)

Date	Site Location	NMOC ppbC Battelle's Total	NMOC ppbC Continuous Total*
7/16/81	St. Vincent	440	Not available
7/17/81	Norwood	620	210
7/17/81	U-Campus	780	410**
7/17/81	Rickoff	1410	1700
7/24/81	Norwood	500	300**
8/5/81	Norwood	2130	Not available
8/5/81	U-Campus	1400	1100**
8/5/81	Rickoff	250	50
8/5/81	St. Vincent	390	290
8/6/81	Norwood	1190	Not available
8/6/81	U-Campus	1160	390
8/7/81	Rickoff	500	550
8/7/81	St. Vincent	980	1030**
8/11/81	Norwood	460	430
8/11/81	U-Campus	490	350**
8/11/81	Rickoff	380	170
8/11/81	St. Vincent	460	390
8/14/81	Norwood	850	950
8/14/81	U-Campus	1020	980**
8/14/81	Rickoff	610	630
8/14/81	St. Vincent	560	680**
8/19/81	Rickoff	580	230
8/19/81	St. Vincent	1220	1390
8/20/81	Norwood	650	310
8/20/81	U-Campus	780	410
8/21/81	Norwood	540	320**
8/21/81	U-Campus	670	390**
8/21/81	Rickoff	480	120
8/21/81	St. Vincent	750	530
8/24/81	Norwood	2010	1470
8/24/81	U-Campus	1870	1560
8/25/81	Norwood	560	450
8/25/81	U-Campus	870	720
8/27/81	Norwood	790	530
8/27/81	U-Campus	890	700
8/27/81	Rickoff	690	370
8/27/81	St. Vincent	940	1150
8/28/81	Rickoff	500	180
8/28/81	St. Vincent	890	460**
8/31/81	St. Vincent	660	360
9/1/81	Norwood	470	280
9/1/81	U-Campus	1030	470
9/3/81	St. Vincent	1060	700

TABLE 2. (Continued)

Date	Site Location	NMOC ppbC Battelle's Total	NMOC ppbC Continuous Total *
9/4/81	Norwood	640	390
9/4/81	U-Campus	610	340
9/4/81	Rickoff	260	350
9/6/81	Rickoff	390	420
9/6/81	St. Vincent	500	70
9/8/81	Norwood	570	350
9/8/81	U-Campus	330	90
9/9/81	U-Campus	630	410**
9/10/81	Norwood	780	690
9/10/81	U-Campus	910	920
9/11/81	Norwood	1100	830
9/11/81	Rickoff	440	Not available
9/11/81	St. Vincent	1870	1300
9/12/81	Norwood	775	540
9/12/81	U-Campus	760	610
9/12/81	St. Vincent	920	270
9/13/81	Norwood	420	210
9/14/81	U-Campus	950	820
9/14/81	Rickoff	380	Not available
9/14/81	St. Vincent	660	400
9/15/81	Norwood	450	190
9/15/81	U-Campus	415	150
9/15/81	Rickoff	410	Not available
9/15/81	St. Vincent	555	480

* This total is a preliminary value.

** One hour of data missing in average.

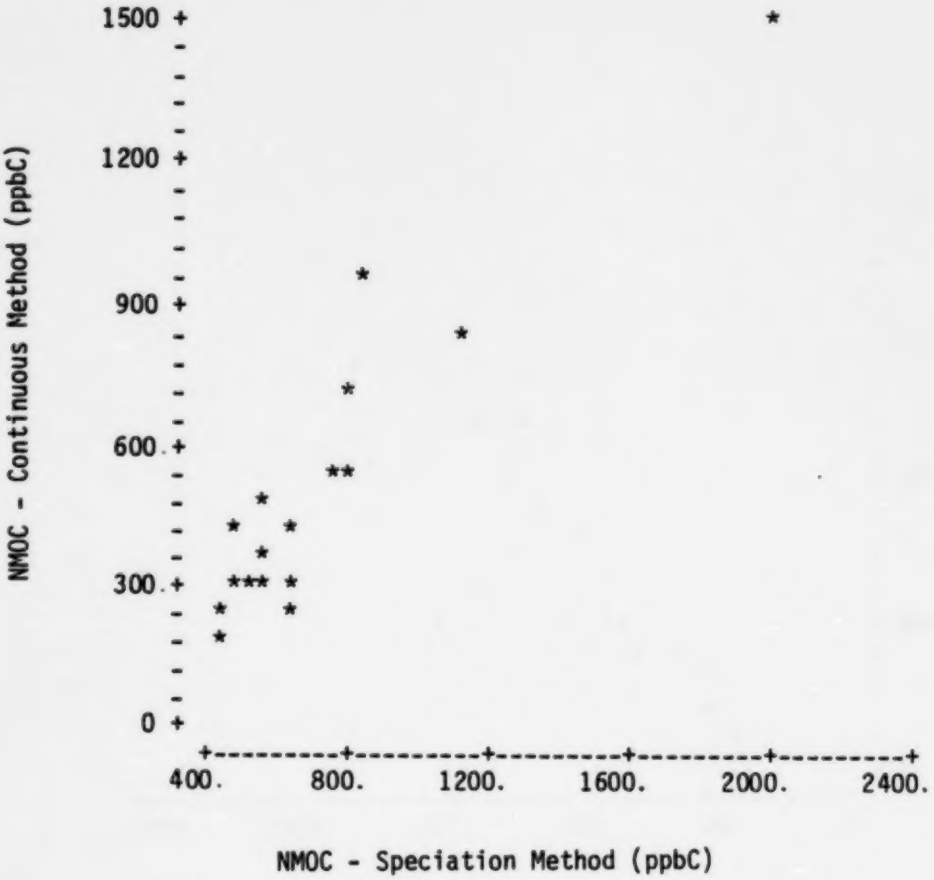


FIGURE 9. COMPARISON OF NON-METHANE ORGANIC CARBON DATA FROM THE NORWOOD SITE IN CINCINNATI

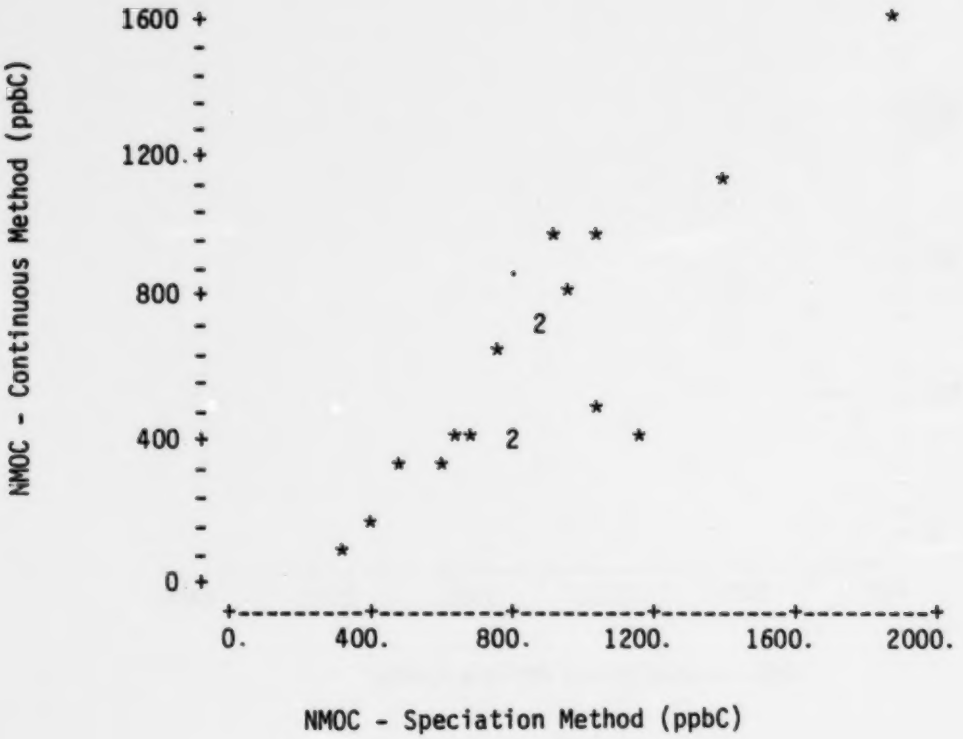


FIGURE 10. COMPARISON OF NON-METHANE ORGANIC CARBON DATA FROM THE UNIVERSITY CAMPUS SITE IN CINCINNATI

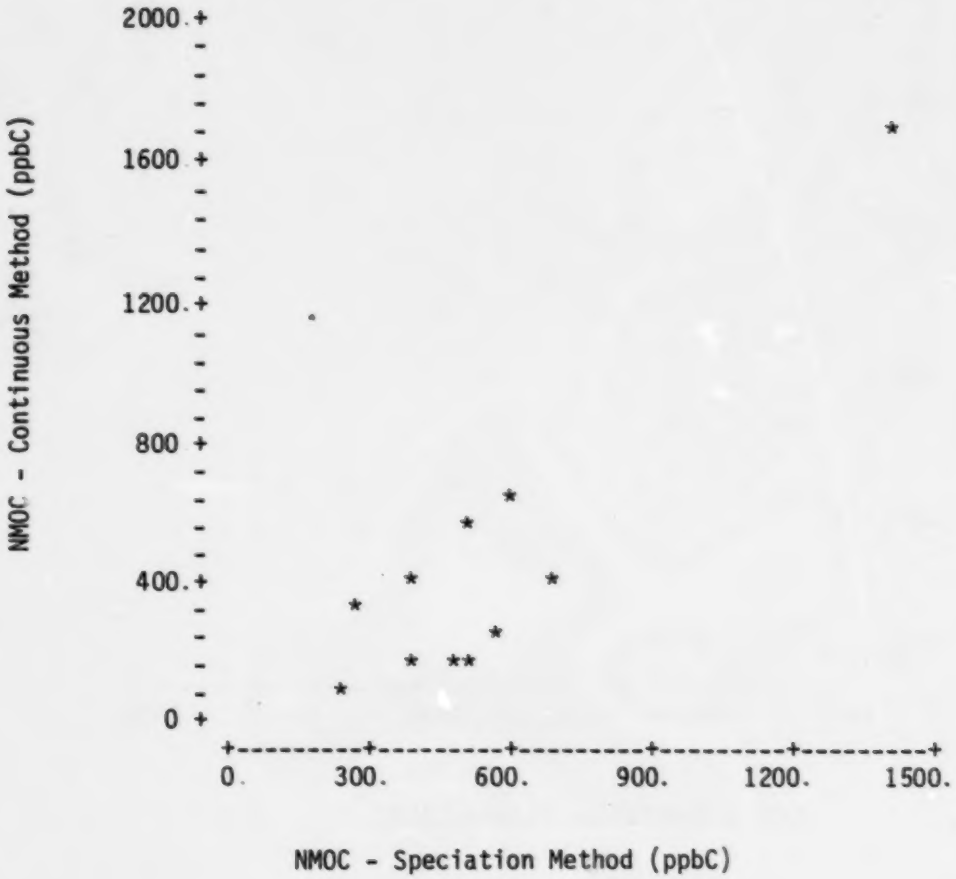


FIGURE 11. COMPARISON OF NON-METHANE ORGANIC CARBON DATA FROM THE RICKOFF SITE IN CLEVELAND

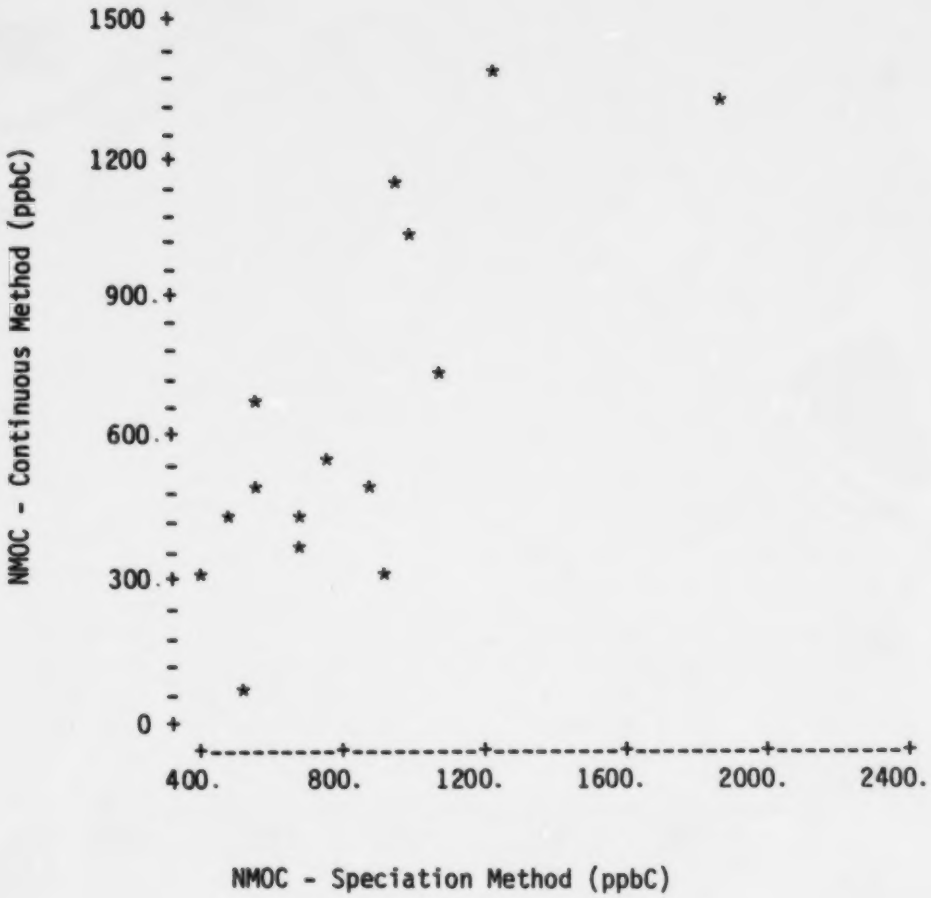


FIGURE 12. COMPARISON OF NON-METHANE ORGANIC CARBON DATA FROM THE ST. VINCENT SITE IN CLEVELAND

At the St. Vincent Site

$$Y = -44.6 + .819\ X$$

and an estimate of the standard deviation of Y about the regression line is 267.9. A correlation coefficient of .75 was found between X and Y.

SECTION 5

QUALITY CONTROL/QUALITY ASSURANCE

A QC/QA work plan was designed and submitted to Region V-EPA prior to the field sampling part of the program. For discussion purposes, these QC/QA activities are divided according to aspects dealing with the field operations and those concerning the laboratory analyses.

FIELD OPERATION ACTIVITIES

Four existing air monitoring sites operated by Ohio EPA personnel served as sampling locations for collecting integrated bag samples (6 to 9 am). Battelle provided four complete sampling units for the site operators. (Each sampling system was laboratory tested prior to use.) Each site operator was also given on-site instruction in the operation procedures for collecting and shipping samples. Additionally a complete and detailed description of each procedure was included along with a daily log book. Daily entries were made in the log book listing the site operator, date, bag and canister number used, and other pertinent sampling information.

For shipping purposes, each site was provided with sufficient pre-paid address labels, shipping cartons, and canister data sheets. These data sheets contained the operator's name, date, site location, can number (pressure) and bag number, and accompanied each shipped canister. Upon receipt, the laboratory analyst immediately checked the canister pressure and signed the attached sheet.

During the field operations a Battelle staff member audited the two Cleveland sites to assure that the correct sampling protocol was being followed. The result of this audit revealed no problems had occurred with the performance of the sampling systems and furthermore showed that correct operating procedures were being adhered to. Budget constraints for travel

prohibited a field audit of the Cincinnati sites. However, phone conversations with the site personnel there confirmed that the sampling system was performing very well. Likewise each site's daily log book was examined after the study and provided additional checks that the field operations had run smoothly.

LABORATORY ANALYSES ACTIVITIES

Instrumentation

The QC/QA activities specifically concerned with gas chromatographic performance include calibration, accuracy, precision and detection and will be discussed as follows:

Calibration--

Calibration of each gas chromatograph was based upon the response from a "certified" NBS propane standard. For the light hydrocarbon (LHC) gas chromatograph both multipoint and single point calibration checks were completed with this NBS propane standard directly. Table 3 depicts the frequency and response factor data of the span and multipoint calibration checks made with this standard. The span checks were detetmined at a concentration of 8.64 ppmC. The multipoint calibration checks incorporated concentrations from 40 ppbC to 800 ppbC. As the data indicate, very good agreement was obtained for response factors from the span and multipoint calibration methods. Furthermore, with the exception of the July 27, 1981 data, all response factors agreed to within 4 percent of the mean value of .0102 ppb/Area 1. A review of the laboratory log book indicated that the hydrogen cylinder was changed on July 24, 1981 and a higher than normal hydrogen flow logged in on July 28, 1981. Lowering the flow and performing a 4 point calibration on July 31 resulted in ppb/Area factor in-line with the mean value. This oversight did not influence the sample accuracy since no samples were analyzed during this time period.

For the heavy hydrocarbon (HHC) instrument, a secondary standard was employed for single and multipoint calibration checks. During the first part of the program, this standard included a mixture of n-pentane, n-hexane

TABLE 3. CALIBRATION RESPONSE FACTOR DATA FOR THE LIGHT HYDROCARBON GAS CHROMATOGRAPH

Date	Calibration Comments	Compound Response Factor (ppb/Area 1) NBS "Certified" Propane
7/15/81	5 Span Checks	.0106
7/16/81	1 Span Check	.0105
7/21/81	4 Point Calibration	.0104
7/27/81	3 Span Checks	.0117
7/31/81	4 Point Calibration	.0104
8/17/81	3 Span Checks	.0098
8/28/81	4 Point Calibration	.0100
8/31/81	2 Span Checks	.0098
9/15/81	2 Span Checks	.0103

and toluene (Mix 1). A second standard (Mix 2) containing i and n pentane, n-hexane, benzene and toluene was prepared and utilized after August 15, 1981. Both secondary standards were cross-checked during the study with the NBS propane cylinder on the LHC gas chromatograph. Table 4 indicates the response factor data obtained during the program on the HHC gas chromatograph. Using Mixtures 1 and 2, span checks were determined at concentrations between 4 and 5 ppmC. Multipoint calibration checks incorporated concentrations from 20 ppbC to 400 ppbC. Again the data indicate very good agreement between the span and multipoint calibration checks. These data also showed that the flame ionization detector was extremely stable. This can readily be seen when viewing the individual response factors from September 1 to September 21, 1981. However, as noted in the table this instrument was extremely sensitive to fuel gas flow adjustments. Consequently a span or multipoint check was always performed immediately following any change of the hydrogen or air cylinder.

Accuracy--

A relative accuracy of $\pm$ 20 percent for each identified compound has been determined from past field studies. A quality assurance program conducted during the summer of 1980 with EPA-ESRL and Washington State University further supports these findings.[4] During these studies interlaboratory comparisons of both ambient samples and EPA-QC mixtures were completed. Similar QC mixtures were analyzed during the present program. (These results will be discussed later on in this section.)

Precision--

During the present study 12 percent of the ambient samples were rerun in order to determine the precision of the analytical method. Furthermore these repeat analyses were performed anywhere from two to six days after the first analysis to see if there were any sample storage effects. Table 5 indicates these results. As indicated, an average percent deviation of less than 4 percent was obtained when comparing the total NMOC value from each analysis. A somewhat lower percent deviation (2.4 percent) was found when comparing the identified NMOC data. No trend was observed in the percent deviations, thus implying good storage stability characteristics of the samples within the aluminum cylinders.

TABLE 4. CALIBRATION RESPONSE FACTOR DATA FOR THE HEAVY HYDROCARBON GAS CHROMATOGRAPH

Date	Calibration Comments	Compound Response Factor (ppbC/Area 1)					
		i-Pentane	n-Pentane	n-Hexane	Benzene	Toluene	Daily Average
7/24/81	Mix 1-4 point calibration	--	.070	.068	--	.071	.070
8/3/81	Changed fuel gases (hydrogen and air)	--	--	--	--	--	--
8/3/81	Mix 1-4 point calibration	--	.047	.045	--	.045	.046
8/4/81	Mix 1-4 point calibration	--	.048	.047	--	.046	.047
8/11/81	Cleaned flame detector -- readjusted H_2/air ratio	--	--	--	--	--	--
8/18/81	Mix 2-4 point calibration	.067	.065	.065	.064	.064	.065
8/26/81	Mix 2-2 span checks	.067	.066	.065	.066	.066	.066
8/27/81	Mix 2-4 point calibration	.067	.064	.067	.068	.070	.067
8/31/81	Changed fuel gases (hydrogen and air)	--	--	--	--	--	--
9/1/81	Mix 2-2 span checks	.061	.060	.060	.061	.060	.060
9/4/81	Mix 2-3 span checks	.062	.061	.060	.061	.060	.061
9/8/81	Mix 2-1 span checks	.062	.061	.061	.061	.060	.061
9/21/81	Mix 2-4 span checks	.060	.060	.059	.060	.060	.060

TABLE 5. REPEAT ANALYSES DURING THE FIELD STUDY

Date	Site Location	Identified NMOC (ppbC)					Total NMOC (ppbC)					Storage Time (days) from Run #1 to Run #2
		Run #1	Run #2	$\bar{x}$	S.D.	% S.D.	Run #1	Run #2	$\bar{x}$	S.D.	% S.D.	
8/5/81	Norwood	1319	1307	1313	8	0.6	2130	2110	2120	14	0.7	1
8/5/81	U-Campus	932	880	906	37	4.1	1400	1330	1365	49	3.6	4
8/14/81	U-Campus	783	768	776	11	1.4	1020	1180	1100	113	10.3	6
8/25/81	U-Campus	607	638	623	22	3.5	870	980	925	78	8.4	3
9/12/81	Norwood	498	487	493	8	1.6	775	730	753	32	4.2	2
9/12/81	U-Campus	511	513	512	1	0.2	760	770	765	7	0.9	2
9/14/81	St. Vincent	447	429	438	13	3.0	670	660	665	7	1.0	2
9/15/81	Rickoff	265	248	257	12	5.0	410	410	410	0	0.0	1
				Average % S.D. = 2.4					Average % S.D. = 3.6			

Detection Limit--

A detection of 1 ppbC when using a 250 cc sample provided a signal to noise ratio of 4/1. Component values below 1 ppbC were not reported.

Aluminum Cylinder Blank Checks

Prior to the initiation of the sampling program, all specially treated aluminum transfer cylinders to be used in the study were modified with a Battelle designed valve system and tested for cleanliness. Each cylinder was filled to 15 psig with zero air (Aadco Clean Air Generator) and stored for at least five days. All cans were then pressure tested and analyzed for non-methane organic compounds using gas chromatographic procedures. Of the original 20 canisters, 19 showed NMOC contributions of less than 10 ppbC. The one "contaminated" cylinder showed several halogenated hydrocarbons as the major components. This cylinder was replaced with another, reexamined and found to contain less than 10 ppbC NMOC.

Sampling Train Blank Checks

Each sampling train consisted of a Metal Bellows pump connected to a transfer tee which in turn was coupled to a Teflon® bag. Each pump was pressure/vacuum tested prior to its installation to assure that the bellows were leak-tight. Each unit was then connected to a manifold of zero air and sampling initiated in identical fashion as field sampling. This included filling the bag over a three hour period and then immediately transferring the contents to an aluminum cylinder. A non-methane organic carbon level of less than 30 ppbC was found in each of the four analyses. Simulated "blank" samples were not repeated at the field sites. However, procedures were performed on a daily basis at the field site which assured minimal contamination carry over from previously collected samples and likewise permitted the operator to determine if the sampling bag leaked.

These quality control measures are given in detail in the Experimental section of this report.

QC Mixtures from EPA-ESRL

During this study Battelle participated in a gas chromatographic audit program coordinated by the EPA laboratories at Research Triangle Park, NC. The purpose of this audit program was to compare all environmental laboratories making detailed hydrocarbon analyses of ambient air with a central laboratory. Presently this central laboratory is the Gas Kinetics and Photochemistry Branch (GKPB) of EPA.

The general procedure used in this QC program involved preparing two treated stainless steel cylinders with C_2 to C_9 hydrocarbon mixtures at the low ppb level. Each mix was analyzed at EPA and immediately shipped to Battelle for analysis. After the Battelle analysis, the cylinders were returned to EPA for repeat analyses to determine any storage loss of the hydrocarbon components. Battelle was required to identify the species present and assign a concentration amount to each component.

Appendix B contains the results of this audit in the form of a memo from the GKPB branch to the OAQPS office. As the memo indicates, Battelle correctly identified the individual species present in each mixture and the concentration level assigned to each component agreed very well with the EPA laboratory results.

REFERENCES

1. Seila, R. L., W. A. Lonneman, and S. A. Meeks, Evaluation of Polyvinyl Fluoride as a Container Material for Air Pollution Samples, J. Environ. Sci. Health--Environ. Sci. Eng., 2:121, 1976.

2. Westberg, H. H., M. W. Holdren, and H. H. Hill, Analytical Methodology for the Identification and Quantification of Vapor Phase Organic Pollutants, Final Report, Project No. CAPA-11-71, Coordinating Research Council (1981).

3. Holdren, M. W., Investigation of Cryogenic Sampling Techniques for Use in Sampling Selected Compounds, Final Report, Contract No. 68-02-3487, U. S. Environmental Protection Agency, Research Triangle Park, NC, 1981.

4. Lonneman, W. A., U. S. Environmental Protection Agency, personal communication. Results not yet published.

APPENDIX A

HYDROCARBON SPECIATION DATA FROM CINCINNATI AND CLEVELAND GROUND SITES SUMMER 1981

OHIO EPA, 1981

Sample I.D. St Vincent Site 7/16/81

	Hydrocarbon	ppb
1.	Ethane	14.3
2.	Ethylene	8.5
3.	Acetylene	19.9
4.	Propane	8.0
5.	Propene	11.7
6.	I-Butane	2.4
7.	N-Butane	16.3
8.	T-2-Butene	-
9.	C-2-Butene	-
10.	I-Pentane	19.4
11.	N-Pentane	5.9
12.	2,3-Dimethylbutane	4.6
13.	2-Methylpentane	11.5
14.	3-Methylpentane	8.3
15.	N-Hexane	13.7
16.	Methylcyclopentane	5.2
17.	2,4-Dimethylpentane	6.8
18.	Benzene	9.1
19.	2-Methylhexane	13.7
20.	3-Methylhexane	5.6
21.	2,2,4-Trimethylpentane	3.8
22.	N-Heptane	2.9
23.	Ethylcyclopentane	3.4
24.	2,4-Dimethylhexane	3.4
25.	Toluene	18.9
26.	2-Methylheptane	2.5
27.	3-Methylheptane	3.5
28.	N-Octane	3.0
29.	Ethylbenzene	4.6
30.	M+P-Xylene	19.2
31.	O-Xylene	5.2
32.	N-Propylbenzene	2.3
33.	P-Ethyltoluene	16.1
34.	1,3,5-Trimethylbenzene	4.4
35.	O-Ethyltoluene	9.8
36.	1,2,4-Trimethylbenzene	10.5
	Identified NMOC	303
	Unidentified NMOC	137
	Total NMOC	440

OHIO EPA, 1981

Sample I.D. Norwood Site 7/12/81

	Hydrocarbon	ppb
1.	Ethane	30.2
2.	Ethylene	16.3
3.	Acetylene	22.2
4.	Propane	27.8
5.	Propene	8.4
6.	I-Butane	11.0
7.	N-Butane	26.4
8.	T-2-Butene	1.1
9.	C-2-Butene	1.0
10.	I-Pentane	28.2
11.	N-Pentane	14.6
12.	2,3-Dimethylbutane	2.1
13.	2-Methylpentane	8.5
14.	3-Methylpentane	8.2
15.	N-Hexane	8.1
16.	Methylcyclopentane	5.8
17.	2,4-Dimethylpentane	8.2
18.	Benzene	8.8
19.	2-Methylhexane	8.5
20.	3-Methylhexane	7.6
21.	2,2,4-Trimethylpentane	2.4
22.	N-Heptane	3.7
23.	Ethylcyclopentane	2.3
24.	2,4-Dimethylhexane	1.2
25.	Toluene	26.2
26.	2-Methylheptane	3.6
27.	3-Methylheptane	3.6
28.	N-Octane	2.5
29.	Ethylbenzene	6.1
30.	M+P-Xylene	12.1
31.	O-Xylene	5.0
32.	N-Propylbenzene	
33.	P-Ethyltoluene	4.8
34.	1,3,5-Trimethylbenzene	3.1
35.	O-Ethyltoluene	11.2
36.	1,2,4-Trimethylbenzene	12.9
	Identified NMOC	359
	Unidentified NMOC	261
	Total NMOC	620

OHIO EPA, 1981

Sample I.D. University Campus Site 7/12/81

	Hydrocarbon	ppb
1.	Ethane	34.3
2.	Ethylene	44.5
3.	Acetylene	23.1
4.	Propane	21.5
5.	Propene	12.1
6.	I-Butane	15.4
7.	N-Butane	33.3
8.	T-2-Butene	1.0
9.	C-2-Butene	1.1
10.	I-Pentane	36.9
11.	N-Pentane	15.1
12.	2,3-Dimethylbutane	.7
13.	2-Methylpentane	31.3
14.	3-Methylpentane	29.7
15.	N-Hexane	11.8
16.	Methylcyclopentane	15.6
17.	2,4-Dimethylpentane	6.3
18.	Benzene	11.8
19.	2-Methylhexane	11.7
20.	3-Methylhexane	8.4
21.	2,2,4-Trimethylpentane	6.5
22.	N-Heptane	6.9
23.	Ethylcyclopentane	3.7
24.	2,4-Dimethylhexane	3.3
25.	Toluene	46.3
26.	2-Methylheptane	4.0
27.	3-Methylheptane	3.6
28.	N-Octane	4.3
29.	Ethylbenzene	3.6
30.	M+P-Xylene	32.8
31.	O-Xylene	8.7
32.	N-Propylbenzene	7.4
33.	P-Ethyltoluene	11.9
34.	1,3,5-Trimethylbenzene	5.3
35.	O-Ethyltoluene	2.3
36.	1,2,4-Trimethylbenzene	18.9
	Identified NMOC	540
	Unidentified NMOC	240
	Total NMOC	780

OHIO EPA, 1981

Sample I.D. Rickoff 7/17/81

	Hydrocarbon	ppb
1.	Ethane	86.4
2.	Ethylene	38.8
3.	Acetylene	27.4
4.	Propane	31.0
5.	Propene	16.8
6.	I-Butane	31.3
7.	N-Butane	74.2
8.	T-2-Butene	-
9.	C-2-Butene	-
10.	I-Pentane	94.3
11.	N-Pentane	45.9
12.	2,3-Dimethylbutane	8.7
13.	2-Methylpentane	36.8
14.	3-Methylpentane	49.6
15.	N-Hexane	22.6
16.	Methylcyclopentane	18.5
17.	2,4-Dimethylpentane	4.6
18.	Benzene	23.9
19.	2-Methylhexane	23.9
20.	3-Methylhexane	23.4
21.	2,2,4-Trimethylpentane	4.7
22.	N-Heptane	12.4
23.	Ethylcyclopentane	7.0
24.	2,4-Dimethylhexane	3.9
25.	Toluene	62.7
26.	2-Methylheptane	4.6
27.	3-Methylheptane	36.6
28.	N-Octane	44.7
29.	Ethylbenzene	12.6
30.	M+P-Xylene	36.7
31.	O-Xylene	13.2
32.	N-Propylbenzene	6.3
33.	P-Ethyltoluene	16.7
34.	1,3,5-Trimethylbenzene	-
35.	O-Ethyltoluene	-
36.	1,2,4-Trimethylbenzene	11.6
	Identified NMOC	937
	Unidentified NMOC	473
	Total NMOC	1410

OHIO EPA, 1981

Sample I.D. Norwood Site 7/24/81

	Hydrocarbon	ppb
1.	Ethane	20.1
2.	Ethylene	18.0
3.	Acetylene	14.7
4.	Propane	17.3
5.	Propene	9.1
6.	I-Butane	8.1
7.	N-Butane	20.2
8.	T-2-Butene	—
9.	C-2-Butene	—
10.	I-Pentane	25.8
11.	N-Pentane	17.2
12.	2,3-Dimethylbutane	1.6
13.	2-Methylpentane	8.4
14.	3-Methylpentane	9.1
15.	N-Hexane	6.3
16.	Methylcyclopentane	5.6
17.	2,4-Dimethylpentane	3.3
18.	Benzene	11.2
19.	2-Methylhexane	5.4
20.	3-Methylhexane	3.1
21.	2,2,4-Trimethylpentane	2.6
22.	N-Heptane	3.0
23.	Ethylcyclopentane	2.8
24.	2,4-Dimethylhexane	—
25.	Toluene	24.5
26.	2-Methylheptane	2.3
27.	3-Methylheptane	3.2
28.	N-Octane	1.6
29.	Ethylbenzene	3.6
30.	M+P-Xylene	18.2
31.	O-Xylene	3.4
32.	N-Propylbenzene	3.5
33.	P-Ethyltoluene	12.4
34.	1,3,5-Trimethylbenzene	—
35.	O-Ethyltoluene	4.8
36.	1,2,4-Trimethylbenzene	14.0
	Identified NMOC	305
	Unidentified NMOC	195
	Total NMOC	500

OHIO EPA, 1981

Sample I.D. Norwood Site 8/5/81

	Hydrocarbon	ppb
1.	Ethane	26.6
2.	Ethylene	43.9
3.	Acetylene	38.7
4.	Propane	44.5
5.	Propene	16.3
6.	I-Butane	32.4
7.	N-Butane	78.7
8.	T-2-Butene	5.3
9.	C-2-Butene	3.5
10.	I-Pentane	96.3
11.	N-Pentane	57.4
12.	2,3-Dimethylbutane	8.7
13.	2-Methylpentane	35.6
14.	3-Methylpentane	27.7
15.	N-Hexane	48.2
16.	Methylcyclopentane	24.8
17.	2,4-Dimethylpentane	7.3
18.	Benzene	23.9
19.	2-Methylhexane	46.9
20.	3-Methylhexane	26.9
21.	2,2,4-Trimethylpentane	9.0
22.	N-Heptane	29.0
23.	Ethylcyclopentane	19.3
24.	2,4-Dimethylhexane	3.8
25.	Toluene	367.5
26.	2-Methylheptane	12.2
27.	3-Methylheptane	14.6
28.	N-Octane	20.0
29.	Ethylbenzene	18.2
30.	M+P-Xylene	55.6
31.	O-Xylene	24.9
32.	N-Propylbenzene	4.1
33.	P-Ethyltoluene	7.8
34.	1,3,5-Trimethylbenzene	9.0
35.	O-Ethyltoluene	8.3
36.	1,2,4-Trimethylbenzene	22.5
	Identified NMOC	1319
	Unidentified NMOC	811
	Total NMOC	2130

OHIO EPA, 1981

Sample I.D. Norwood 8/5/81 Repeat Analysis

	Hydrocarbon	ppb
1.	Ethane	26.2
2.	Ethylene	45.0
3.	Acetylene	37.2
4.	Propane	44.0
5.	Propene	12.0
6.	I-Butane	32.8
7.	N-Butane	78.7
8.	T-2-Butene	5.0
9.	C-2-Butene	3.9
10.	I-Pentane	94.3
11.	N-Pentane	53.7
12.	2,3-Dimethylbutane	9.0
13.	2-Methylpentane	37.0
14.	3-Methylpentane	28.6
15.	N-Hexane	48.7
16.	Methylcyclopentane	25.6
17.	2,4-Dimethylpentane	5.2
18.	Benzene	21.7
19.	2-Methylhexane	45.8
20.	3-Methylhexane	26.7
21.	2,2,4-Trimethylpentane	9.0
22.	N-Heptane	27.9
23.	Ethylcyclopentane	21.4
24.	2,4-Dimethylhexane	4.2
25.	Toluene	365.0
26.	2-Methylheptane	15.3
27.	3-Methylheptane	17.2
28.	N-Octane	16.2
29.	Ethylbenzene	18.5
30.	M+P-Xylene	53.9
31.	O-Xylene	23.9
32.	N-Propylbenzene	3.2
33.	P-Ethyltoluene	7.4
34.	1,3,5-Trimethylbenzene	6.4
35.	O-Ethyltoluene	9.5
36.	1,2,4-Trimethylbenzene	21.6
	Identified NMOC	1307
	Unidentified NMOC	803
	Total NMOC	2110

OHIO EPA, 1981

Sample I.D. University Campus Site 8/5/81

	Hydrocarbon	ppb
1.	Ethane	33.0
2.	Ethylene	71.1
3.	Acetylene	33.6
4.	Propane	26.7
5.	Propene	22.5
6.	I-Butane	42.4
7.	N-Butane	95.5
8.	T-2-Butene	6.2
9.	C-2-Butene	4.5
10.	I-Pentane	108.7
11.	N-Pentane	55.7
12.	2,3-Dimethylbutane	8.7
13.	2-Methylpentane	33.3
14.	3-Methylpentane	23.7
15.	N-Hexane	25.2
16.	Methylcyclopentane	18.5
17.	2,4-Dimethylpentane	7.4
18.	Benzene	32.9
19.	2-Methylhexane	36.0
20.	3-Methylhexane	14.0
21.	2,2,4-Trimethylpentane	4.2
22.	N-Heptane	11.5
23.	Ethylcyclopentane	6.3
24.	2,4-Dimethylhexane	2.8
25.	Toluene	67.5
26.	2-Methylheptane	8.3
27.	3-Methylheptane	8.7
28.	N-Octane	8.1
29.	Ethylbenzene	10.9
30.	M+P-Xylene	44.9
31.	O-Xylene	13.6
32.	N-Propylbenzene	2.7
33.	P-Ethyltoluene	8.5
34.	1,3,5-Trimethylbenzene	5.5
35.	O-Ethyltoluene	13.0
36.	1,2,4-Trimethylbenzene	16.1
	Identified NMOC	932
	Unidentified NMOC	468
	Total NMOC	1400

OHIO EPA, 1981

Sample I.D. University Campus Site 8/5/81 Repeat Analysis

	Hydrocarbon	ppb
1.	Ethane	30.3
2.	Ethylene	65.9
3.	Acetylene	30.5
4.	Propane	25.1
5.	Propene	19.3
6.	I-Butane	37.1
7.	N-Butane	86.2
8.	T-2-Butene	5.6
9.	C-2-Butene	4.2
10.	I-Pentane	101.1
11.	N-Pentane	53.2
12.	2,3-Dimethylbutane	8.1
13.	2-Methylpentane	32.6
14.	3-Methylpentane	23.2
15.	N-Hexane	24.4
16.	Methylcyclopentane	18.1
17.	2,4-Dimethylpentane	2.0
18.	Benzene	32.6
19.	2-Methylhexane	24.8
20.	3-Methylhexane	16.8
21.	2,2,4-Trimethylpentane	3.8
22.	N-Heptane	12.5
23.	Ethylcyclopentane	6.0
24.	2,4-Dimethylhexane	3.2
25.	Toluene	64.0
26.	2-Methylheptane	6.9
27.	3-Methylheptane	3.0
28.	N-Octane	3.4
29.	Ethylbenzene	14.0
30.	M+P-Xylene	46.8
31.	O-Xylene	15.1
32.	N-Propylbenzene	2.7
33.	P-Ethyltoluene	9.1
34.	1,3,5-Trimethylbenzene	6.6
35.	O-Ethyltoluene	13.2
36.	1,2,4-Trimethylbenzene	18.9
	Identified NMOC	880
	Unidentified NMOC	450
	Total NMOC	1330

OHIO EPA, 1981

Sample I.D. Rickoff Site 8/5/81

	Hydrocarbon	ppb
1.	Ethane	2.5
2.	Ethylene	5.9
3.	Acetylene	3.7
4.	Propane	3.3
5.	Propene	4.4
6.	I-Butane	4.5
7.	N-Butane	10.3
8.	T-2-Butene	—
9.	C-2-Butene	—
10.	I-Pentane	12.6
11.	N-Pentane	2.5
12.	2,3-Dimethylbutane	.7
13.	2-Methylpentane	2.9
14.	3-Methylpentane	4.8
15.	N-Hexane	2.1
16.	Methylcyclopentane	2.7
17.	2,4-Dimethylpentane	.8
18.	Benzene	3.1
19.	2-Methylhexane	3.8
20.	3-Methylhexane	2.4
21.	2,2,4-Trimethylpentane	1.1
22.	N-Heptane	.8
23.	Ethylcyclopentane	1.1
24.	2,4-Dimethylhexane	—
25.	Toluene	16.6
26.	2-Methylheptane	4.5
27.	3-Methylheptane	2.1
28.	N-Octane	—
29.	Ethylbenzene	1.5
30.	M+P-Xylene	7.0
31.	O-Xylene	2.5
32.	N-Propylbenzene	2.0
33.	P-Ethyltoluene	3.9
34.	1,3,5-Trimethylbenzene	4.6
35.	O-Ethyltoluene	1.8
36.	1,2,4-Trimethylbenzene	8.0
	Identified NMOC	123
	Unidentified NMOC	127
	Total NMOC	250

OHIO EPA, 1981

Sample I.D. St. Vincent Site 8/5/81

	Hydrocarbon	ppb
1.	Ethane	6.9
2.	Ethylene	12.3
3.	Acetylene	12.8
4.	Propane	4.7
5.	Propene	6.6
6.	I-Butane	6.3
7.	N-Butane	15.9
8.	T-2-Butene	—
9.	C-2-Butene	—
10.	I-Pentane	19.9
11.	N-Pentane	6.5
12.	2,3-Dimethylbutane	1.8
13.	2-Methylpentane	6.2
14.	3-Methylpentane	6.0
15.	N-Hexane	3.8
16.	Methylcyclopentane	3.8
17.	2,4-Dimethylpentane	6.0
18.	Benzene	6.3
19.	2-Methylhexane	16.4
20.	3-Methylhexane	6.9
21.	2,2,4-Trimethylpentane	2.7
22.	N-Heptane	3.0
23.	Ethylcyclopentane	3.4
24.	2,4-Dimethylhexane	3.2
25.	Toluene	21.6
26.	2-Methylheptane	2.0
27.	3-Methylheptane	4.6
28.	N-Octane	2.4
29.	Ethylbenzene	4.5
30.	M+P-Xylene	17.1
31.	O-Xylene	8.7
32.	N-Propylbenzene	1.4
33.	P-Ethyltoluene	4.8
34.	1,3,5-Trimethylbenzene	4.1
35.	O-Ethyltoluene	16.6
36.	1,2,4-Trimethylbenzene	9.7
	Identified NMOC	260
	Unidentified NMOC	130
	Total NMOC	390

OHIO EPA, 1981

Sample I.D. Norwood Site 8/6/81

	Hydrocarbon	ppb
1.	Ethane	12.7
2.	Ethylene	15.5
3.	Acetylene	12.8
4.	Propane	15.7
5.	Propene	8.4
6.	I-Butane	14.1
7.	N-Butane	32.4
8.	T-2-Butene	3.1
9.	C-2-Butene	2.1
10.	I-Pentane	37.8
11.	N-Pentane	19.6
12.	2,3-Dimethylbutane	2.0
13.	2-Methylpentane	8.8
14.	3-Methylpentane	7.7
15.	N-Hexane	8.3
16.	Methylcyclopentane	10.4
17.	2,4-Dimethylpentane	4.5
18.	Benzene	8.4
19.	2-Methylhexane	17.1
20.	3-Methylhexane	17.6
21.	2,2,4-Trimethylpentane	4.1
22.	N-Heptane	16.2
23.	Ethylcyclopentane	11.9
24.	2,4-Dimethylhexane	2.9
25.	Toluene	111.2
26.	2-Methylheptane	8.7
27.	3-Methylheptane	11.5
28.	N-Octane	—
29.	Ethylbenzene	4.9
30.	M+P-Xylene	9.5
31.	O-Xylene	5.9
32.	N-Propylbenzene	—
33.	P-Ethyltoluene	4.2
34.	1,3,5-Trimethylbenzene	2.8
35.	O-Ethyltoluene	10.1
36.	1,2,4-Trimethylbenzene	9.2
	Identified NMOC	477
	Unidentified NMOC	713
	Total NMOC	1190

OHIO EPA, 1981

Sample I.D. University Campus Site 8/6/81

	Hydrocarbon	ppb
1.	Ethane	13.4
2.	Ethylene	44.1
3.	Acetylene	23.3
4.	Propane	9.2
5.	Propene	14.3
6.	I-Butane	13.8
7.	N-Butane	37.6
8.	T-2-Butene	3.1
9.	C-2-Butene	2.1
10.	I-Pentane	45.0
11.	N-Pentane	16.8
12.	2,3-Dimethylbutane	4.9
13.	2-Methylpentane	16.0
14.	3-Methylpentane	12.9
15.	N-Hexane	13.0
16.	Methylcyclopentane	16.7
17.	2,4-Dimethylpentane	6.7
18.	Benzene	24.8
19.	2-Methylhexane	16.8
20.	3-Methylhexane	9.4
21.	2,2,4-Trimethylpentane	3.6
22.	N-Heptane	8.8
23.	Ethylcyclopentane	3.4
24.	2,4-Dimethylhexane	2.4
25.	Toluene	45.4
26.	2-Methylheptane	4.3
27.	3-Methylheptane	12.2
28.	N-Octane	5.5
29.	Ethylbenzene	9.9
30.	M+P-Xylene	28.1
31.	O-Xylene	8.7
32.	N-Propylbenzene	3.9
33.	P-Ethyltoluene	8.7
34.	1,3,5-Trimethylbenzene	6.4
35.	O-Ethyltoluene	3.9
36.	1,2,4-Trimethylbenzene	14.3
	Identified NMOC	514
	Unidentified NMOC	646
	Total NMOC	1160

OHIO EPA, 1981

Sample I.D. Rickoff Site 8/7/81

	Hydrocarbon	ppb
1.	Ethane	63.1
2.	Ethylene	13.5
3.	Acetylene	9.6
4.	Propane	21.5
5.	Propene	21.9
6.	I-Butane	17.6
7.	N-Butane	35.4
8.	T-2-Butene	1.4
9.	C-2-Butene	1.3
10.	I-Pentane	49.0
11.	N-Pentane	12.0
12.	2,3-Dimethylbutane	3.1
13.	2-Methylpentane	14.0
14.	3-Methylpentane	12.2
15.	N-Hexane	7.8
16.	Methylcyclopentane	4.9
17.	2,4-Dimethylpentane	1.1
18.	Benzene	5.7
19.	2-Methylhexane	7.3
20.	3-Methylhexane	4.8
21.	2,2,4-Trimethylpentane	1.4
22.	N-Heptane	2.7
23.	Ethylcyclopentane	2.2
24.	2,4-Dimethylhexane	.8
25.	Toluene	13.7
26.	2-Methylheptane	3.4
27.	3-Methylheptane	2.7
28.	N-Octane	1.7
29.	Ethylbenzene	3.1
30.	M+P-Xylene	12.6
31.	O-Xylene	4.2
32.	N-Propylbenzene	1.4
33.	P-Ethyltoluene	3.4
34.	1,3,5-Trimethylbenzene	2.5
35.	O-Ethyltoluene	2.1
36.	1,2,4-Trimethylbenzene	9.5
	Identified NMOC	385
	Unidentified NMOC	115
	Total NMOC	500

OHIO EPA, 1981

Sample I.D. St Vincent Site 8/7/81

	Hydrocarbon	ppb
1.	Ethane	41.1
2.	Ethylene	36.8
3.	Acetylene	47.7
4.	Propane	26.1
5.	Propene	13.6
6.	I-Butane	19.5
7.	N-Butane	46.6
8.	T-2-Butene	1.8
9.	C-2-Butene	1.0
10.	I-Pentane	42.1
11.	N-Pentane	22.2
12.	2,3-Dimethylbutane	3.8
13.	2-Methylpentane	17.4
14.	3-Methylpentane	14.1
15.	N-Hexane	15.7
16.	Methylcyclopentane	11.6
17.	2,4-Dimethylpentane	7.4
18.	Benzene	27.6
19.	2-Methylhexane	16.4
20.	3-Methylhexane	9.8
21.	2,2,4-Trimethylpentane	3.4
22.	N-Heptane	9.4
23.	Ethylcyclopentane	6.2
24.	2,4-Dimethylhexane	2.5
25.	Toluene	42.6
26.	2-Methylheptane	4.9
27.	3-Methylheptane	2.7
28.	N-Octane	6.0
29.	Ethylbenzene	11.1
30.	M+P-Xylene	24.2
31.	O-Xylene	9.4
32.	N-Propylbenzene	2.1
33.	P-Ethyltoluene	6.4
34.	1,3,5-Trimethylbenzene	3.5
35.	O-Ethyltoluene	10.4
36.	1,2,4-Trimethylbenzene	9.2
	Identified NMOC	587
	Unidentified NMOC	393
	Total NMOC	980

OHIO EPA, 1981

Sample I.D. Norwood Site 8/11/81

	Hydrocarbon	ppb
1.	Ethane	11.3
2.	Ethylene	10.7
3.	Acetylene	21.6
4.	Propane	12.6
5.	Propene	4.2
6.	I-Butane	9.4
7.	N-Butane	23.7
8.	T-2-Butene	1.4
9.	C-2-Butene	1.3
10.	I-Pentane	30.5
11.	N-Pentane	17.9
12.	2,3-Dimethylbutane	2.1
13.	2-Methylpentane	9.1
14.	3-Methylpentane	8.1
15.	N-Hexane	7.8
16.	Methylcyclopentane	5.3
17.	2,4-Dimethylpentane	1.4
18.	Benzene	6.4
19.	2-Methylhexane	4.4
20.	3-Methylhexane	6.3
21.	2,2,4-Trimethylpentane	2.4
22.	N-Heptane	9.2
23.	Ethylcyclopentane	2.7
24.	2,4-Dimethylhexane	1.0
25.	Toluene	72.8
26.	2-Methylheptane	3.5
27.	3-Methylheptane	3.2
28.	N-Octane	2.5
29.	Ethylbenzene	7.4
30.	M+P-Xylene	15.8
31.	O-Xylene	4.9
32.	N-Propylbenzene	1.0
33.	P-Ethyltoluene	3.1
34.	1,3,5-Trimethylbenzene	3.8
35.	O-Ethyltoluene	2.4
36.	1,2,4-Trimethylbenzene	8.8
	Identified NMOC	346
	Unidentified NMOC	114
	Total NMOC	460

OHIO EPA, 1981

Sample I.D. University Campus Site 8/11/81

	Hydrocarbon	ppb
1.	Ethane	11.4
2.	Ethylene	33.5
3.	Acetylene	19.6
4.	Propane	8.6
5.	Propene	11.5
6.	I-Butane	12.5
7.	N-Butane	29.5
8.	T-2-Butene	2.5
9.	C-2-Butene	2.0
10.	I-Pentane	33.9
11.	N-Pentane	16.6
12.	2,3-Dimethylbutane	2.2
13.	2-Methylpentane	12.3
14.	3-Methylpentane	9.4
15.	N-Hexane	10.1
16.	Methylcyclopentane	6.6
17.	2,4-Dimethylpentane	1.5
18.	Benzene	13.6
19.	2-Methylhexane	9.0
20.	3-Methylhexane	4.9
21.	2,2,4-Trimethylpentane	1.8
22.	N-Heptane	2.2
23.	Ethylcyclopentane	2.5
24.	2,4-Dimethylhexane	1.1
25.	Toluene	32.1
26.	2-Methylheptane	3.6
27.	3-Methylheptane	3.4
28.	N-Octane	2.5
29.	Ethylbenzene	5.7
30.	M+P-Xylene	23.4
31.	O-Xylene	7.0
32.	N-Propylbenzene	1.5
33.	P-Ethyltoluene	5.5
34.	1,3,5-Trimethylbenzene	6.4
35.	O-Ethyltoluene	4.1
36.	1,2,4-Trimethylbenzene	14.0
	Identified NMOC	373
	Unidentified NMOC	117
	Total NMOC	490

OHIO EPA, 1981

Sample I.D. Rickoff Site 8/11/81

	Hydrocarbon	ppb
1.	Ethane	19.0
2.	Ethylene	4.8
3.	Acetylene	9.0
4.	Propane	12.0
5.	Propene	2.4
6.	I-Butane	9.7
7.	N-Butane	21.7
8.	T-2-Butene	—
9.	C-2-Butene	—
10.	I-Pentane	20.7
11.	N-Pentane	10.7
12.	2,3-Dimethylbutane	2.2
13.	2-Methylpentane	7.6
14.	3-Methylpentane	4.0
15.	N-Hexane	4.9
16.	Methylcyclopentane	3.4
17.	2,4-Dimethylpentane	1.4
18.	Benzene	6.3
19.	2-Methylhexane	4.8
20.	3-Methylhexane	2.9
21.	2,2,4-Trimethylpentane	1.3
22.	N-Heptane	6.7
23.	Ethylcyclopentane	3.1
24.	2,4-Dimethylhexane	—
25.	Toluene	15.1
26.	2-Methylheptane	2.2
27.	3-Methylheptane	1.7
28.	N-Octane	1.7
29.	Ethylbenzene	3.2
30.	M+P-Xylene	12.3
31.	O-Xylene	2.5
32.	N-Propylbenzene	.7
33.	P-Ethyltoluene	2.5
34.	1,3,5-Trimethylbenzene	1.5
35.	O-Ethyltoluene	2.0
36.	1,2,4-Trimethylbenzene	10.5
	Identified NMOC	232
	Unidentified NMOC	148
	Total NMOC	380

OHIO EPA, 1981

Sample I.D. St. Vincent Site 8/11/81

	Hydrocarbon	ppb
1.	Ethane	10.0
2.	Ethylene	15.9
3.	Acetylene	24.2
4.	Propane	2.1
5.	Propene	2.8
6.	I-Butane	2.1
7.	N-Butane	12.4
8.	T-2-Butene	—
9.	C-2-Butene	—
10.	I-Pentane	21.2
11.	N-Pentane	6.6
12.	2,3-Dimethylbutane	1.5
13.	2-Methylpentane	6.6
14.	3-Methylpentane	6.0
15.	N-Hexane	4.1
16.	Methylcyclopentane	3.1
17.	2,4-Dimethylpentane	1.4
18.	Benzene	2.3
19.	2-Methylhexane	4.5
20.	3-Methylhexane	3.2
21.	2,2,4-Trimethylpentane	1.7
22.	N-Heptane	6.3
23.	Ethylcyclopentane	5.4
24.	2,4-Dimethylhexane	—
25.	Toluene	22.3
26.	2-Methylheptane	2.4
27.	3-Methylheptane	2.2
28.	N-Octane	1.8
29.	Ethylbenzene	3.6
30.	M+P-Xylene	14.4
31.	O-Xylene	4.8
32.	N-Propylbenzene	1.3
33.	P-Ethyltoluene	4.6
34.	1,3,5-Trimethylbenzene	3.9
35.	O-Ethyltoluene	2.2
36.	1,2,4-Trimethylbenzene	14.4
	Identified NMOC	244
	Unidentified NMOC	216
	Total NMOC	460

OHIO EPA, 1981

Sample I.D. Norwood Site 8/14/81

	Hydrocarbon	ppb
1.	Ethane	14.6
2.	Ethylene	22.4
3.	Acetylene	19.9
4.	Propane	39.3
5.	Propene	9.4
6.	I-Butane	16.3
7.	N-Butane	36.0
8.	T-2-Butene	2.2
9.	C-2-Butene	1.7
10.	I-Pentane	39.2
11.	N-Pentane	21.9
12.	2,3-Dimethylbutane	3.1
13.	2-Methylpentane	14.0
14.	3-Methylpentane	11.6
15.	N-Hexane	16.4
16.	Methylcyclopentane	11.3
17.	2,4-Dimethylpentane	2.0
18.	Benzene	11.2
19.	2-Methylhexane	18.9
20.	3-Methylhexane	14.0
21.	2,2,4-Trimethylpentane	4.6
22.	N-Heptane	16.1
23.	Ethylcyclopentane	7.1
24.	2,4-Dimethylhexane	1.3
25.	Toluene	203.4
26.	2-Methylheptane	5.6
27.	3-Methylheptane	4.5
28.	N-Octane	3.4
29.	Ethylbenzene	5.6
30.	M+P-Xylene	20.2
31.	O-Xylene	8.7
32.	N-Propylbenzene	1.5
33.	P-Ethyltoluene	5.2
34.	1,3,5-Trimethylbenzene	3.6
35.	O-Ethyltoluene	3.2
36.	1,2,4-Trimethylbenzene	14.6
	Identified NMOC	634
	Unidentified NMOC	216
	Total NMOC	850

OHIO EPA, 1981

Sample I.D. University Campus Site 8/14/81

	Hydrocarbon	ppb
1.	Ethane	25.1
2.	Ethylene	87.1
3.	Acetylene	35.8
4.	Propane	20.2
5.	Propene	23.0
6.	I-Butane	21.1
7.	N-Butane	54.1
8.	T-2-Butene	5.3
9.	C-2-Butene	3.8
10.	I-Pentane	75.0
11.	N-Pentane	41.7
12.	2,3-Dimethylbutane	16.6
13.	2-Methylpentane	26.7
14.	3-Methylpentane	19.2
15.	N-Hexane	20.2
16.	Methylcyclopentane	17.9
17.	2,4-Dimethylpentane	6.2
18.	Benzene	27.9
19.	2-Methylhexane	20.7
20.	3-Methylhexane	11.5
21.	2,2,4-Trimethylpentane	41
22.	N-Heptane	16.0
23.	Ethylcyclopentane	6.2
24.	2,4-Dimethylhexane	2.7
25.	Toluene	64.4
26.	2-Methylheptane	7.4
27.	3-Methylheptane	6.9
28.	N-Octane	4.9
29.	Ethylbenzene	11.5
30.	M+P-Xylene	43.8
31.	O-Xylene	15.3
32.	N-Propylbenzene	2.8
33.	P-Ethyltoluene	9.2
34.	1,3,5-Trimethylbenzene	6.0
35.	O-Ethyltoluene	6.2
36.	1,2,4-Trimethylbenzene	25.2
	Identified NMOC	783
	Unidentified NMOC	237
	Total NMOC	1020

OHIO EPA, 1981

Sample I.D. University Campus Site 8/14/81 Repeat Analysis

	Hydrocarbon	ppb
1.	Ethane	24.6
2.	Ethylene	85.5
3.	Acetylene	34.0
4.	Propane	19.2
5.	Propene	20.5
6.	I-Butane	22.0
7.	N-Butane	53.6
8.	T-2-Butene	5.9
9.	C-2-Butene	3.9
10.	I-Pentane	73.7
11.	N-Pentane	39.9
12.	2,3-Dimethylbutane	1.6
13.	2-Methylpentane	25.8
14.	3-Methylpentane	16.7
15.	N-Hexane	19.6
16.	Methylcyclopentane	16.1
17.	2,4-Dimethylpentane	1.1
18.	Benzene	28.7
19.	2-Methylhexane	18.6
20.	3-Methylhexane	11.1
21.	2,2,4-Trimethylpentane	3.9
22.	N-Heptane	24.1
23.	Ethylcyclopentane	6.2
24.	2,4-Dimethylhexane	2.5
25.	Toluene	59.4
26.	2-Methylheptane	6.3
27.	3-Methylheptane	7.4
28.	N-Octane	6.3
29.	Ethylbenzene	11.5
30.	M+P-Xylene	42.8
31.	O-Xylene	15.0
32.	N-Propylbenzene	3.8
33.	P-Ethyltoluene	11.5
34.	1,3,5-Trimethylbenzene	9.0
35.	O-Ethyltoluene	8.1
36.	1,2,4-Trimethylbenzene	23.7
	Identified NMOC	768
	Unidentified NMOC	412
	Total NMOC	1180

OHIO EPA, 1981

Sample I.D. Rickoff Site 8/14/81

	Hydrocarbon	ppb
1.	Ethane	28.4
2.	Ethylene	17.2
3.	Acetylene	12.0
4.	Propane	16.7
5.	Propene	10.1
6.	I-Butane	14.1
7.	N-Butane	29.3
8.	T-2-Butene	1.7
9.	C-2-Butene	.8
10.	I-Pentane	36.1
11.	N-Pentane	14.4
12.	2,3-Dimethylbutane	2.9
13.	2-Methylpentane	10.5
14.	3-Methylpentane	7.3
15.	N-Hexane	16.5
16.	Methylcyclopentane	5.3
17.	2,4-Dimethylpentane	3.2
18.	Benzene	10.6
19.	2-Methylhexane	7.1
20.	3-Methylhexane	3.9
21.	2,2,4-Trimethylpentane	3.2
22.	N-Heptane	4.4
23.	Ethylcyclopentane	2.7
24.	2,4-Dimethylhexane	.8
25.	Toluene	21.0
26.	2-Methylheptane	2.7
27.	3-Methylheptane	2.5
28.	N-Octane	2.4
29.	Ethylbenzene	4.6
30.	M+P-Xylene	15.7
31.	O-Xylene	5.3
32.	N-Propylbenzene	2.1
33.	P-Ethyltoluene	4.5
34.	1,3,5-Trimethylbenzene	1.8
35.	O-Ethyltoluene	3.9
36.	1,2,4-Trimethylbenzene	10.1
	Identified NMOC	340
	Unidentified NMOC	270
	Total NMOC	610

OHIO EPA, 1981

Sample I.D. St Vincent Site 8/14/81

	Hydrocarbon	ppb
1.	Ethane	18.8
2.	Ethylene	24.3
3.	Acetylene	27.1
4.	Propane	11.8
5.	Propene	8.8
6.	I-Butane	13.5
7.	N-Butane	34.9
8.	T-2-Butene	1.7
9.	C-2-Butene	1.0
10.	I-Pentane	42.8
11.	N-Pentane	18.0
12.	2,3-Dimethylbutane	3.1
13.	2-Methylpentane	13.0
14.	3-Methylpentane	11.1
15.	N-Hexane	8.1
16.	Methylcyclopentane	7.0
17.	2,4-Dimethylpentane	1.7
18.	Benzene	12.9
19.	2-Methylhexane	2.4
20.	3-Methylhexane	4.9
21.	2,2,4-Trimethylpentane	1.5
22.	N-Heptane	6.6
23.	Ethylcyclopentane	2.4
24.	2,4-Dimethylhexane	1.0
25.	Toluene	27.2
26.	2-Methylheptane	3.5
27.	3-Methylheptane	3.5
28.	N-Octane	2.8
29.	Ethylbenzene	5.2
30.	M+P-Xylene	19.5
31.	O-Xylene	7.6
32.	N-Propylbenzene	1.4
33.	P-Ethyltoluene	4.6
34.	1,3,5-Trimethylbenzene	3.4
35.	O-Ethyltoluene	3.2
36.	1,2,4-Trimethylbenzene	12.3
	Identified NMOC	381
	Unidentified NMOC	179
	Total NMOC	560

OHIO EPA, 1981

Sample I.D. Rickoff Site 8/19/81

	Hydrocarbon	ppb
1.	Ethane	23.1
2.	Ethylene	14.0
3.	Acetylene	11.9
4.	Propane	16.9
5.	Propene	27.0
6.	I-Butane	13.5
7.	N-Butane	24.8
8.	T-2-Butene	—
9.	C-2-Butene	—
10.	I-Pentane	27.1
11.	N-Pentane	13.0
12.	2,3-Dimethylbutane	2.3
13.	2-Methylpentane	8.1
14.	3-Methylpentane	15.8
15.	N-Hexane	5.2
16.	Methylcyclopentane	4.6
17.	2,4-Dimethylpentane	2.7
18.	Benzene	2.7
19.	2-Methylhexane	5.5
20.	3-Methylhexane	3.5
21.	2,2,4-Trimethylpentane	1.0
22.	N-Heptane	4.6
23.	Ethylcyclopentane	1.7
24.	2,4-Dimethylhexane	.8
25.	Toluene	19.9
26.	2-Methylheptane	1.5
27.	3-Methylheptane	1.8
28.	N-Octane	2.1
29.	Ethylbenzene	4.1
30.	M+P-Xylene	14.6
31.	O-Xylene	1.5
32.	N-Propylbenzene	1.3
33.	P-Ethyltoluene	3.6
34.	1,3,5-Trimethylbenzene	4.1
35.	O-Ethyltoluene	1.4
36.	1,2,4-Trimethylbenzene	9.2
	Identified NMOC	300
	Unidentified NMOC	280
	Total NMOC	580

OHIO EPA, 1981

Sample I.D. St. Vincent Site 8/19/81

	Hydrocarbon	ppb
1.	Ethane	44.5
2.	Ethylene	40.8
3.	Acetylene	36.2
4.	Propane	28.9
5.	Propene	17.6
6.	I-Butane	26.6
7.	N-Butane	68.9
8.	T-2-Butene	3.6
9.	C-2-Butene	2.2
10.	I-Pentane	75.3
11.	N-Pentane	32.0
12.	2,3-Dimethylbutane	5.7
13.	2-Methylpentane	22.0
14.	3-Methylpentane	15.0
15.	N-Hexane	14.7
16.	Methylcyclopentane	11.1
17.	2,4-Dimethylpentane	4.2
18.	Benzene	22.8
19.	2-Methylhexane	14.4
20.	3-Methylhexane	9.5
21.	2,2,4-Trimethylpentane	8.0
22.	N-Heptane	6.9
23.	Ethylcyclopentane	2.1
24.	2,4-Dimethylhexane	1.8
25.	Toluene	43.1
26.	2-Methylheptane	4.3
27.	3-Methylheptane	7.4
28.	N-Octane	6.3
29.	Ethylbenzene	9.0
30.	M+P-Xylene	25.8
31.	O-Xylene	4.5
32.	N-Propylbenzene	2.7
33.	P-Ethyltoluene	6.0
34.	1,3,5-Trimethylbenzene	6.4
35.	O-Ethyltoluene	2.9
36.	1,2,4-Trimethylbenzene	11.1
	Identified NMOC	649
	Unidentified NMOC	571
	Total NMOC	1220

OHIO EPA, 1981

Sample I.D. Norwood Site 8/20/81

	Hydrocarbon	ppb
1.	Ethane	19.1
2.	Ethylene	15.2
3.	Acetylene	36.2
4.	Propane	15.6
5.	Propene	6.2
6.	I-Butane	10.2
7.	N-Butane	24.7
8.	T-2-Butene	1.4
9.	C-2-Butene	.8
10.	I-Pentane	25.5
11.	N-Pentane	7.7
12.	2,3-Dimethylbutane	2.1
13.	2-Methylpentane	9.4
14.	3-Methylpentane	7.8
15.	N-Hexane	12.0
16.	Methylcyclopentane	7.0
17.	2,4-Dimethylpentane	6.6
18.	Benzene	7.8
19.	2-Methylhexane	7.3
20.	3-Methylhexane	4.8
21.	2,2,4-Trimethylpentane	1.7
22.	N-Heptane	2.4
23.	Ethylcyclopentane	3.5
24.	2,4-Dimethylhexane	.7
25.	Toluene	55.7
26.	2-Methylheptane	2.0
27.	3-Methylheptane	2.7
28.	N-Octane	2.0
29.	Ethylbenzene	3.8
30.	M+P-Xylene	13.6
31.	O-Xylene	—
32.	N-Propylbenzene	1.1
33.	P-Ethyltoluene	2.9
34.	1,3,5-Trimethylbenzene	2.8
35.	O-Ethyltoluene	—
36.	1,2,4-Trimethylbenzene	6.9
	Identified NMOC	334
	Unidentified NMOC	316
	Total NMOC	650

OHIO EPA, 1981

Sample I.D. University Campus Site 8/20/81

	Hydrocarbon	ppb
1.	Ethane	23.1
2.	Ethylene	22.7
3.	Acetylene	14.1
4.	Propane	19.1
5.	Propene	7.9
6.	I-Butane	31.7
7.	N-Butane	38.6
8.	T-2-Butene	2.0
9.	C-2-Butene	1.7
10.	I-Pentane	38.6
11.	N-Pentane	18.0
12.	2,3-Dimethylbutane	3.1
13.	2-Methylpentane	11.6
14.	3-Methylpentane	8.5
15.	N-Hexane	9.8
16.	Methylcyclopentane	7.3
17.	2,4-Dimethylpentane	—
18.	Benzene	9.1
19.	2-Methylhexane	9.1
20.	3-Methylhexane	6.0
21.	2,2,4-Trimethylpentane	2.1
22.	N-Heptane	2.8
23.	Ethylcyclopentane	3.8
24.	2,4-Dimethylhexane	.8
25.	Toluene	47.0
26.	2-Methylheptane	2.9
27.	3-Methylheptane	2.8
28.	N-Octane	2.8
29.	Ethylbenzene	4.8
30.	M+P-Xylene	17.6
31.	O-Xylene	1.0
32.	N-Propylbenzene	1.7
33.	P-Ethyltoluene	4.2
34.	1,3,5-Trimethylbenzene	3.8
35.	O-Ethyltoluene	.7
36.	1,2,4-Trimethylbenzene	9.2
	Identified NMOC	396
	Unidentified NMOC	384
	Total NMOC	780

OHIO EPA, 1981

Sample I.D. Norwood Site 8/21/81

	Hydrocarbon	ppb
1.	Ethane	18.3
2.	Ethylene	16.4
3.	Acetylene	20.8
4.	Propane	12.2
5.	Propene	5.3
6.	I-Butane	4.9
7.	N-Butane	23.6
8.	T-2-Butene	1.3
9.	C-2-Butene	.7
10.	I-Pentane	26.8
11.	N-Pentane	13.1
12.	2,3-Dimethylbutane	1.8
13.	2-Methylpentane	8.0
14.	3-Methylpentane	6.2
15.	N-Hexane	12.8
16.	Methylcyclopentane	5.0
17.	2,4-Dimethylpentane	4.1
18.	Benzene	8.7
19.	2-Methylhexane	5.2
20.	3-Methylhexane	3.1
21.	2,2,4-Trimethylpentane	—
22.	N-Heptane	4.3
23.	Ethylcyclopentane	2.0
24.	2,4-Dimethylhexane	—
25.	Toluene	25.5
26.	2-Methylheptane	1.5
27.	3-Methylheptane	2.2
28.	N-Octane	2.5
29.	Ethylbenzene	3.6
30.	M+P-Xylene	12.0
31.	O-Xylene	—
32.	N-Propylbenzene	1.0
33.	P-Ethyltoluene	3.1
34.	1,3,5-Trimethylbenzene	2.8
35.	O-Ethyltoluene	—
36.	1,2,4-Trimethylbenzene	7.6
	Identified NMOC	282
	Unidentified NMOC	258
	Total NMOC	540

OHIO EPA, 1981

Sample I.D. University Campus Site 8/21/81

	Hydrocarbon	ppb
1.	Ethane	22.7
2.	Ethylene	28.8
3.	Acetylene	17.4
4.	Propane	19.1
5.	Propene	10.0
6.	I-Butane	24.2
7.	N-Butane	43.0
8.	T-2-Butene	2.1
9.	C-2-Butene	1.4
10.	I-Pentane	38.2
11.	N-Pentane	19.4
12.	2,3-Dimethylbutane	2.9
13.	2-Methylpentane	11.2
14.	3-Methylpentane	7.6
15.	N-Hexane	8.4
16.	Methylcyclopentane	6.0
17.	2,4-Dimethylpentane	2.8
18.	Benzene	9.1
19.	2-Methylhexane	7.3
20.	3-Methylhexane	4.6
21.	2,2,4-Trimethylpentane	1.5
22.	N-Heptane	7.0
23.	Ethylcyclopentane	2.5
24.	2,4-Dimethylhexane	1.0
25.	Toluene	38.2
26.	2-Methylheptane	2.1
27.	3-Methylheptane	2.8
28.	N-Octane	2.7
29.	Ethylbenzene	5.0
30.	M+P-Xylene	18.1
31.	O-Xylene	—
32.	N-Propylbenzene	1.4
33.	P-Ethyltoluene	4.1
34.	1,3,5-Trimethylbenzene	3.3
35.	O-Ethyltoluene	1.4
36.	1,2,4-Trimethylbenzene	10.8
	Identified NMOC	388
	Unidentified NMOC	282
	Total NMOC	670

OHIO EPA, 1981

Sample I.D. Rickoff Site 8/2/81

	Hydrocarbon	ppb
1.	Ethane	22.1
2.	Ethylene	15.1
3.	Acetylene	9.6
4.	Propane	14.8
5.	Propene	5.7
6.	I-Butane	11.5
7.	N-Butane	26.3
8.	T-2-Butene	1.0
9.	C-2-Butene	—
10.	I-Pentane	32.6
11.	N-Pentane	14.0
12.	2,3-Dimethylbutane	2.1
13.	2-Methylpentane	9.9
14.	3-Methylpentane	6.6
15.	N-Hexane	6.1
16.	Methylcyclopentane	5.3
17.	2,4-Dimethylpentane	4.3
18.	Benzene	8.7
19.	2-Methylhexane	2.3
20.	3-Methylhexane	4.8
21.	2,2,4-Trimethylpentane	1.4
22.	N-Heptane	5.3
23.	Ethylcyclopentane	2.0
24.	2,4-Dimethylhexane	1.5
25.	Toluene	20.0
26.	2-Methylheptane	1.8
27.	3-Methylheptane	2.2
28.	N-Octane	2.2
29.	Ethylbenzene	3.5
30.	M+P-Xylene	12.2
31.	O-Xylene	1.8
32.	N-Propylbenzene	1.1
33.	P-Ethyltoluene	3.6
34.	1,3,5-Trimethylbenzene	3.4
35.	O-Ethyltoluene	1.8
36.	1,2,4-Trimethylbenzene	3.3
	Identified NMOC	280
	Unidentified NMOC	200
	Total NMOC	480

OHIO EPA, 1981

Sample I.D. St. Vincent Site 8/21/81

	Hydrocarbon	ppb
1.	Ethane	22.4
2.	Ethylene	23.7
3.	Acetylene	35.5
4.	Propane	15.0
5.	Propene	9.6
6.	I-Butane	11.0
7.	N-Butane	27.4
8.	T-2-Butene	1.5
9.	C-2-Butene	.8
10.	I-Pentane	33.4
11.	N-Pentane	15.1
12.	2,3-Dimethylbutane	14.1
13.	2-Methylpentane	10.9
14.	3-Methylpentane	8.0
15.	N-Hexane	9.4
16.	Methylcyclopentane	6.3
17.	2,4-Dimethylpentane	1.7
18.	Benzene	13.2
19.	2-Methylhexane	9.8
20.	3-Methylhexane	6.6
21.	2,2,4-Trimethylpentane	3.9
22.	N-Heptane	10.1
23.	Ethylcyclopentane	6.9
24.	2,4-Dimethylhexane	1.1
25.	Toluene	25.1
26.	2-Methylheptane	3.9
27.	3-Methylheptane	6.0
28.	N-Octane	7.3
29.	Ethylbenzene	5.0
30.	M+P-Xylene	18.6
31.	O-Xylene	2.5
32.	N-Propylbenzene	2.2
33.	P-Ethyltoluene	5.5
34.	1,3,5-Trimethylbenzene	5.9
35.	O-Ethyltoluene	2.2
36.	1,2,4-Trimethylbenzene	12.2
	Identified NMOC	394
	Unidentified NMOC	356
	Total NMOC	750

OHIO EPA, 1981

Sample I.D. Norwood Site 8/24/81

	Hydrocarbon	ppb
1.	Ethane	30.2
2.	Ethylene	69.1
3.	Acetylene	25.1
4.	Propane	58.6
5.	Propene	30.7
6.	I-Butane	36.1
7.	N-Butane	93.7
8.	T-2-Butene	2.7
9.	C-2-Butene	5.2
10.	I-Pentane	123.5
11.	N-Pentane	68.7
12.	2,3-Dimethylbutane	10.2
13.	2-Methylpentane	40.9
14.	3-Methylpentane	27.6
15.	N-Hexane	35.0
16.	Methylcyclopentane	22.8
17.	2,4-Dimethylpentane	6.6
18.	Benzene	32.3
19.	2-Methylhexane	27.9
20.	3-Methylhexane	18.2
21.	2,2,4-Trimethylpentane	6.6
22.	N-Heptane	19.5
23.	Ethylcyclopentane	10.6
24.	2,4-Dimethylhexane	2.9
25.	Toluene	138.3
26.	2-Methylheptane	7.6
27.	3-Methylheptane	13.0
28.	N-Octane	12.0
29.	Ethylbenzene	17.8
30.	M+P-Xylene	56.9
31.	O-Xylene	2.8
32.	N-Propylbenzene	4.5
33.	P-Ethyltoluene	9.4
34.	1,3,5-Trimethylbenzene	11.9
35.	O-Ethyltoluene	2.1
36.	1,2,4-Trimethylbenzene	17.1
	Identified NMOC	1153
	Unidentified NMOC	857
	Total NMOC	2010

OHIO EPA, 1981

Sample I.D. University Campus Site 8/24/81

	Hydrocarbon	ppb
1.	Ethane	43.2
2.	Ethylene	113.5
3.	Acetylene	44.1
4.	Propane	23.8
5.	Propene	29.8
6.	I-Butane	44.3
7.	N-Butane	115.9
8.	T-2-Butene	9.7
9.	C-2-Butene	6.4
10.	I-Pentane	137.3
11.	N-Pentane	68.6
12.	2,3-Dimethylbutane	11.1
13.	2-Methylpentane	42.8
14.	3-Methylpentane	28.0
15.	N-Hexane	33.7
16.	Methylcyclopentane	27.2
17.	2,4-Dimethylpentane	4.3
18.	Benzene	35.1
19.	2-Methylhexane	25.6
20.	3-Methylhexane	14.6
21.	2,2,4-Trimethylpentane	5.2
22.	N-Heptane	15.1
23.	Ethylcyclopentane	2.7
24.	2,4-Dimethylhexane	3.1
25.	Toluene	73.5
26.	2-Methylheptane	6.7
27.	3-Methylheptane	9.2
28.	N-Octane	6.9
29.	Ethylbenzene	12.5
30.	M+P-Xylene	42.4
31.	O-Xylene	15.3
32.	N-Propylbenzene	3.6
33.	P-Ethyltoluene	9.5
34.	1,3,5-Trimethylbenzene	7.8
35.	O-Ethyltoluene	7.9
36.	1,2,4-Trimethylbenzene	17.2
	Identified NMOC	1108
	Unidentified NMOC	762
	Total NMOC	1870

OHIO EPA, 1981

Sample I.D. Norwood Site 8/25/81

	Hydrocarbon	ppb
1.	Ethane	19.1
2.	Ethylene	25.5
3.	Acetylene	29.7
4.	Propane	21.5
5.	Propene	9.5
6.	I-Butane	14.2
7.	N-Butane	8.3.2
8.	T-2-Butene	2.4
9.	C-2-Butene	1.5
10.	I-Pentane	42.0
11.	N-Pentane	18.8
12.	2,3-Dimethylbutane	3.3
13.	2-Methylpentane	13.0
14.	3-Methylpentane	9.1
15.	N-Hexane	12.2
16.	Methylcyclopentane	7.1
17.	2,4-Dimethylpentane	1.7
18.	Benzene	12.8
19.	2-Methylhexane	8.5
20.	3-Methylhexane	5.5
21.	2,2,4-Trimethylpentane	2.1
22.	N-Heptane	7.1
23.	Ethylcyclopentane	3.3
24.	2,4-Dimethylhexane	0.9
25.	Toluene	37.1
26.	2-Methylheptane	2.7
27.	3-Methylheptane	3.9
28.	N-Octane	3.7
29.	Ethylbenzene	5.3
30.	M+P-Xylene	17.9
31.	O-Xylene	6.2
32.	N-Propylbenzene	1.9
33.	P-Ethyltoluene	4.2
34.	1,3,5-Trimethylbenzene	5.3
35.	O-Ethyltoluene	—
36.	1,2,4-Trimethylbenzene	8.4
	Identified NMOC	401
	Unidentified NMOC	159
	Total NMOC	560

OHIO EPA, 1981

Sample I.D. University Campus Site 8/25/81

	Hydrocarbon	ppb
1.	Ethane	27.2
2.	Ethylene	53.0
3.	Acetylene	20.9
4.	Propane	23.3
5.	Propene	12.2
6.	I-Butane	23.2
7.	N-Butane	47.7
8.	T-2-Butene	3.6
9.	C-2-Butene	2.6
10.	I-Pentane	58.1
11.	N-Pentane	26.7
12.	2,3-Dimethylbutane	4.4
13.	2-Methylpentane	18.2
14.	3-Methylpentane	12.6
15.	N-Hexane	13.7
16.	Methylcyclopentane	10.1
17.	2,4-Dimethylpentane	6.0
18.	Benzene	17.2
19.	2-Methylhexane	12.4
20.	3-Methylhexane	7.6
21.	2,2,4-Trimethylpentane	2.7
22.	N-Heptane	9.6
23.	Ethylcyclopentane	4.7
24.	2,4-Dimethylhexane	1.7
25.	Toluene	75.3
26.	2-Methylheptane	4.1
27.	3-Methylheptane	5.8
28.	N-Octane	4.8
29.	Ethylbenzene	11.9
30.	M+P-Xylene	38.6
31.	O-Xylene	12.6
32.	N-Propylbenzene	2.5
33.	P-Ethyltoluene	7.4
34.	1,3,5-Trimethylbenzene	8.1
35.	O-Ethyltoluene	4.7
36.	1,2,4-Trimethylbenzene	11.7
	Identified NMOC	607
	Unidentified NMOC	263
	Total NMOC	870

OHIO EPA, 1981

Sample I.D. University Campus Site 8/25/81 Repeat Analysis

	Hydrocarbon	ppb
1.	Ethane	28.0
2.	Ethylene	52.7
3.	Acetylene	22.6
4.	Propane	24.1
5.	Propene	13.1
6.	I-Butane	24.8
7.	N-Butane	48.0
8.	T-2-Butene	3.5
9.	C-2-Butene	2.6
10.	I-Pentane	58.1
11.	N-Pentane	29.5
12.	2,3-Dimethylbutane	5.1
13.	2-Methylpentane	18.1
14.	3-Methylpentane	12.0
15.	N-Hexane	14.9
16.	Methylcyclopentane	10.8
17.	2,4-Dimethylpentane	6.2
18.	Benzene	17.6
19.	2-Methylhexane	11.4
20.	3-Methylhexane	8.2
21.	2,2,4-Trimethylpentane	4.0
22.	N-Heptane	10.2
23.	Ethylcyclopentane	4.6
24.	2,4-Dimethylhexane	1.6
25.	Toluene	76.2
26.	2-Methylheptane	4.0
27.	3-Methylheptane	2.5
28.	N-Octane	6.3
29.	Ethylbenzene	12.7
30.	M+P-Xylene	40.8
31.	O-Xylene	14.1
32.	N-Propylbenzene	2.5
33.	P-Ethyltoluene	9.8
34.	1,3,5-Trimethylbenzene	13.2
35.	O-Ethyltoluene	7.1
36.	1,2,4-Trimethylbenzene	12.5
	Identified NMOC	638
	Unidentified NMOC	342
	Total NMOC	980

OHIO EPA, 1981

Sample I.D. Norwood Site 8/27/81

	Hydrocarbon	ppb
1.	Ethane	17.0
2.	Ethylene	22.4
3.	Acetylene	25.8
4.	Propane	23.5
5.	Propene	11.1
6.	I-Butane	12.4
7.	N-Butane	29.5
8.	T-2-Butene	2.5
9.	C-2-Butene	1.5
10.	I-Pentane	38.1
11.	N-Pentane	20.1
12.	2,3-Dimethylbutane	3.1
13.	2-Methylpentane	13.4
14.	3-Methylpentane	9.8
15.	N-Hexane	15.5
16.	Methylcyclopentane	9.2
17.	2,4-Dimethylpentane	5.1
18.	Benzene	12.7
19.	2-Methylhexane	11.0
20.	3-Methylhexane	8.1
21.	2,2,4-Trimethylpentane	2.1
22.	N-Heptane	13.0
23.	Ethylcyclopentane	7.0
24.	2,4-Dimethylhexane	1.3
25.	Toluene	105.2
26.	2-Methylheptane	4.9
27.	3-Methylheptane	4.2
28.	N-Octane	6.1
29.	Ethylbenzene	6.7
30.	M+P-Xylene	23.7
31.	O-Xylene	8.3
32.	N-Propylbenzene	2.3
33.	P-Ethyltoluene	5.4
34.	1,3,5-Trimethylbenzene	7.2
35.	O-Ethyltoluene	1.2
36.	1,2,4-Trimethylbenzene	12.3
	Identified NMOC	503
	Unidentified NMOC	282
	Total NMOC	785

OHIO EPA, 1981

Sample I.D. University Campus Site 8/27/81

	Hydrocarbon	ppb
1.	Ethane	20.9
2.	Ethylene	66.6
3.	Acetylene	26.2
4.	Propane	13.6
5.	Propene	14.5
6.	I-Butane	17.0
7.	N-Butane	42.8
8.	T-2-Butene	4.1
9.	C-2-Butene	2.7
10.	I-Pentane	60.7
11.	N-Pentane	28.9
12.	2,3-Dimethylbutane	5.3
13.	2-Methylpentane	20.9
14.	3-Methylpentane	14.1
15.	N-Hexane	15.0
16.	Methylcyclopentane	11.3
17.	2,4-Dimethylpentane	2.1
18.	Benzene	22.0
19.	2-Methylhexane	15.4
20.	3-Methylhexane	9.0
21.	2,2,4-Trimethylpentane	2.8
22.	N-Heptane	11.2
23.	Ethylcyclopentane	4.7
24.	2,4-Dimethylhexane	2.0
25.	Toluene	500
26.	2-Methylheptane	4.5
27.	3-Methylheptane	5.9
28.	N-Octane	5.3
29.	Ethylbenzene	9.6
30.	M+P-Xylene	36.1
31.	O-Xylene	13.3
32.	N-Propylbenzene	3.7
33.	P-Ethyltoluene	10.7
34.	1,3,5-Trimethylbenzene	7.8
35.	O-Ethyltoluene	5.4
36.	1,2,4-Trimethylbenzene	21.5
	Identified NMOC	610
	Unidentified NMOC	275
	Total NMOC	885

OHIO EPA, 1981

Sample I.D. Rickoff Site 8/27/81

	Hydrocarbon	ppb
1.	Ethane	55.3
2.	Ethylene	23.0
3.	Acetylene	15.1
4.	Propane	31.9
5.	Propene	7.5
6.	I-Butane	18.9
7.	N-Butane	43.3
8.	T-2-Butene	1.6
9.	C-2-Butene	1.1
10.	I-Pentane	46.9
11.	N-Pentane	24.0
12.	2,3-Dimethylbutane	4.8
13.	2-Methylpentane	15.7
14.	3-Methylpentane	11.5
15.	N-Hexane	13.6
16.	Methylcyclopentane	8.9
17.	2,4-Dimethylpentane	4.5
18.	Benzene	12.1
19.	2-Methylhexane	13.1
20.	3-Methylhexane	9.2
21.	2,2,4-Trimethylpentane	2.4
22.	N-Heptane	9.6
23.	Ethylcyclopentane	4.1
24.	2,4-Dimethylhexane	1.3
25.	Toluene	35.6
26.	2-Methylheptane	.34
27.	3-Methylheptane	4.5
28.	N-Octane	4.3
29.	Ethylbenzene	5.8
30.	M+P-Xylene	20.7
31.	O-Xylene	7.4
32.	N-Propylbenzene	1.9
33.	P-Ethyltoluene	5.6
34.	1,3,5-Trimethylbenzene	6.7
35.	O-Ethyltoluene	3.1
36.	1,2,4-Trimethylbenzene	10.7
	Identified NMOC	489
	Unidentified NMOC	201
	Total NMOC	690

OHIO EPA, 1981

Sample I.D. St. Vincent Site 8/27/81

	Hydrocarbon	ppb
1.	Ethane	55.6
2.	Ethylene	43.1
3.	Acetylene	54.3
4.	Propane	34.0
5.	Propene	16.4
6.	I-Butane	22.4
7.	N-Butane	54.0
8.	T-2-Butene	3.0
9.	C-2-Butene	1.7
10.	I-Pentane	64.3
11.	N-Pentane	27.3
12.	2,3-Dimethylbutane	4.9
13.	2-Methylpentane	20.1
14.	3-Methylpentane	14.9
15.	N-Hexane	17.7
16.	Methylcyclopentane	11.2
17.	2,4-Dimethylpentane	2.8
18.	Benzene	22.5
19.	2-Methylhexane	16.2
20.	3-Methylhexane	12.1
21.	2,2,4-Trimethylpentane	2.8
22.	N-Heptane	14.2
23.	Ethylcyclopentane	2.7
24.	2,4-Dimethylhexane	1.8
25.	Toluene	48.7
26.	2-Methylheptane	4.7
27.	3-Methylheptane	2.7
28.	N-Octane	2.3
29.	Ethylbenzene	2.3
30.	M+P-Xylene	27.0
31.	O-Xylene	9.7
32.	N-Propylbenzene	3.1
33.	P-Ethyltoluene	8.4
34.	1,3,5-Trimethylbenzene	9.4
35.	O-Ethyltoluene	2.7
36.	1,2,4-Trimethylbenzene	16.0
	Identified NMOC	673
	Unidentified NMOC	267
	Total NMOC	940

OHIO EPA, 1981

Sample I.D. Rickoff Site 8/28/81

	Hydrocarbon	ppb
1.	Ethane	18.9
2.	Ethylene	15.2
3.	Acetylene	10.8
4.	Propane	12.5
5.	Propene	2.7
6.	I-Butane	9.6
7.	N-Butane	20.9
8.	T-2-Butene	1.2
9.	C-2-Butene	1.0
10.	I-Pentane	25.5
11.	N-Pentane	12.1
12.	2,3-Dimethylbutane	2.8
13.	2-Methylpentane	10.1
14.	3-Methylpentane	7.2
15.	N-Hexane	8.8
16.	Methylcyclopentane	6.2
17.	2,4-Dimethylpentane	1.6
18.	Benzene	8.8
19.	2-Methylhexane	10.3
20.	3-Methylhexane	7.7
21.	2,2,4-Trimethylpentane	1.7
22.	N-Heptane	8.1
23.	Ethylcyclopentane	2.3
24.	2,4-Dimethylhexane	0.9
25.	Toluene	29.2
26.	2-Methylheptane	1.9
27.	3-Methylheptane	2.7
28.	N-Octane	2.5
29.	Ethylbenzene	6.4
30.	M+P-Xylene	23.3
31.	O-Xylene	7.7
32.	N-Propylbenzene	1.5
33.	P-Ethyltoluene	4.7
34.	1,3,5-Trimethylbenzene	4.0
35.	O-Ethyltoluene	4.0
36.	1,2,4-Trimethylbenzene	10.5
	Identified NMOC	311
	Unidentified NMOC	189
	Total NMOC	500

OHIO EPA, 1981

Sample I.D. St. Vincent Site 8/28/81

	Hydrocarbon	ppb
1.	Ethane	30.8
2.	Ethylene	29.6
3.	Acetylene	28.9
4.	Propane	20.7
5.	Propene	14.5
6.	I-Butane	17.8
7.	N-Butane	42.5
8.	T-2-Butene	2.3
9.	C-2-Butene	1.3
10.	I-Pentane	45.4
11.	N-Pentane	20.2
12.	2,3-Dimethylbutane	3.6
13.	2-Methylpentane	15.0
14.	3-Methylpentane	10.6
15.	N-Hexane	11.4
16.	Methylcyclopentane	9.8
17.	2,4-Dimethylpentane	2.0
18.	Benzene	17.4
19.	2-Methylhexane	9.9
20.	3-Methylhexane	6.4
21.	2,2,4-Trimethylpentane	3.4
22.	N-Heptane	8.7
23.	Ethylcyclopentane	4.9
24.	2,4-Dimethylhexane	1.3
25.	Toluene	34.9
26.	2-Methylheptane	3.3
27.	3-Methylheptane	5.0
28.	N-Octane	4.9
29.	Ethylbenzene	6.9
30.	M+P-Xylene	23.1
31.	O-Xylene	8.3
32.	N-Propylbenzene	3.7
33.	P-Ethyltoluene	7.4
34.	1,3,5-Trimethylbenzene	7.5
35.	O-Ethyltoluene	3.5
36.	1,2,4-Trimethylbenzene	15.6
	Identified NMOC	483
	Unidentified NMOC	407
	Total NMOC	890

OHIO EPA, 1981

Sample I.D. St. Vincent Site 8/31/81

	Hydrocarbon	ppb
1.	Ethane	31.1
2.	Ethylene	19.0
3.	Acetylene	13.5
4.	Propane	21.4
5.	Propene	9.4
6.	I-Butane	18.3
7.	N-Butane	44.1
8.	T-2-Butene	1.7
9.	C-2-Butene	1.1
10.	I-Pentane	42.4
11.	N-Pentane	17.3
12.	2,3-Dimethylbutane	3.0
13.	2-Methylpentane	11.7
14.	3-Methylpentane	7.8
15.	N-Hexane	8.3
16.	Methylcyclopentane	6.3
17.	2,4-Dimethylpentane	2.1
18.	Benzene	14.0
19.	2-Methylhexane	7.8
20.	3-Methylhexane	5.0
21.	2,2,4-Trimethylpentane	2.8
22.	N-Heptane	8.5
23.	Ethylcyclopentane	3.0
24.	2,4-Dimethylhexane	0.9
25.	Toluene	24.4
26.	2-Methylheptane	2.6
27.	3-Methylheptane	2.8
28.	N-Octane	3.2
29.	Ethylbenzene	5.2
30.	M+P-Xylene	16.9
31.	O-Xylene	5.7
32.	N-Propylbenzene	2.1
33.	P-Ethyltoluene	4.8
34.	1,3,5-Trimethylbenzene	11.0
35.	O-Ethyltoluene	0.9
36.	1,2,4-Trimethylbenzene	12.4
	Identified NMOC	393
	Unidentified NMOC	262
	Total NMOC	655

OHIO EPA, 1981

Sample I.D. Norwood Site 9/1/81

	Hydrocarbon	ppb
1.	Ethane	10.4
2.	Ethylene	17.2
3.	Acetylene	21.0
4.	Propane	12.9
5.	Propene	7.5
6.	I-Butane	10.2
7.	N-Butane	23.9
8.	T-2-Butene	2.2
9.	C-2-Butene	1.5
10.	I-Pentane	29.2
11.	N-Pentane	15.6
12.	2,3-Dimethylbutane	2.4
13.	2-Methylpentane	9.7
14.	3-Methylpentane	6.3
15.	N-Hexane	6.9
16.	Methylcyclopentane	5.1
17.	2,4-Dimethylpentane	1.0
18.	Benzene	10.2
19.	2-Methylhexane	2.1
20.	3-Methylhexane	4.6
21.	2,2,4-Trimethylpentane	1.5
22.	N-Heptane	8.0
23.	Ethylcyclopentane	4.0
24.	2,4-Dimethylhexane	1.0
25.	Toluene	49.1
26.	2-Methylheptane	2.7
27.	3-Methylheptane	3.7
28.	N-Octane	5.7
29.	Ethylbenzene	3.8
30.	M+P-Xylene	13.1
31.	O-Xylene	3.2
32.	N-Propylbenzene	1.0
33.	P-Ethyltoluene	3.4
34.	1,3,5-Trimethylbenzene	7.5
35.	O-Ethyltoluene	—
36.	1,2,4-Trimethylbenzene	8.8
	Identified NMOC	321
	Unidentified NMOC	149
	Total NMOC	470

OHIO EPA, 1981

Sample I.D. University Campus Site 9/1/81

	Hydrocarbon	ppb
1.	Ethane	17.0
2.	Ethylene	54.9
3.	Acetylene	25.8
4.	Propane	12.2
5.	Propene	16.1
6.	I-Butane	15.2
7.	N-Butane	41.7
8.	T-2-Butene	4.2
9.	C-2-Butene	2.7
10.	I-Pentane	57.7
11.	N-Pentane	25.7
12.	2,3-Dimethylbutane	4.9
13.	2-Methylpentane	18.6
14.	3-Methylpentane	12.1
15.	N-Hexane	13.0
16.	Methylcyclopentane	9.7
17.	2,4-Dimethylpentane	1.1
18.	Benzene	19.0
19.	2-Methylhexane	12.7
20.	3-Methylhexane	7.6
21.	2,2,4-Trimethylpentane	2.3
22.	N-Heptane	12.7
23.	Ethylcyclopentane	3.8
24.	2,4-Dimethylhexane	1.6
25.	Toluene	41.9
26.	2-Methylheptane	6.4
27.	3-Methylheptane	6.0
28.	N-Octane	6.5
29.	Ethylbenzene	8.6
30.	M+P-Xylene	31.0
31.	O-Xylene	10.8
32.	N-Propylbenzene	2.8
33.	P-Ethyltoluene	9.1
34.	1,3,5-Trimethylbenzene	8.0
35.	O-Ethyltoluene	5.6
36.	1,2,4-Trimethylbenzene	21.4
	Identified NMOC	551
	Unidentified NMOC	479
	Total NMOC	1030

OHIO EPA, 1981

Sample I.D. St Vincent Site 9/3/81

	Hydrocarbon	ppb
1.	Ethane	44.0
2.	Ethylene	29.2
3.	Acetylene	19.9
4.	Propane	31.3
5.	Propene	11.0
6.	I-Butane	21.9
7.	N-Butane	51.2
8.	T-2-Butene	2.6
9.	C-2-Butene	2.1
10.	I-Pentane	62.9
11.	N-Pentane	26.5
12.	2,3-Dimethylbutane	4.7
13.	2-Methylpentane	18.7
14.	3-Methylpentane	12.8
15.	N-Hexane	13.5
16.	Methylcyclopentane	10.0
17.	2,4-Dimethylpentane	3.6
18.	Benzene	16.3
19.	2-Methylhexane	11.6
20.	3-Methylhexane	7.6
21.	2,2,4-Trimethylpentane	3.1
22.	N-Heptane	13.3
23.	Ethylcyclopentane	4.2
24.	2,4-Dimethylhexane	1.4
25.	Toluene	32.9
26.	2-Methylheptane	5.4
27.	3-Methylheptane	5.9
28.	N-Octane	5.0
29.	Ethylbenzene	8.4
30.	M+P-Xylene	29.7
31.	O-Xylene	10.7
32.	N-Propylbenzene	3.6
33.	P-Ethyltoluene	10.5
34.	1,3,5-Trimethylbenzene	16.1
35.	O-Ethyltoluene	7.4
36.	1,2,4-Trimethylbenzene	23.0
	Identified NMOC	586
	Unidentified NMOC	474
	Total NMOC	1060

OHIO EPA, 1981

Sample I.D. Norwood Site 9/4/81

	Hydrocarbon	ppb
1.	Ethane	12.4
2.	Ethylene	14.4
3.	Acetylene	23.3
4.	Propane	14.4
5.	Propene	9.1
6.	I-Butane	15.4
7.	N-Butane	36.2
8.	T-2-Butene	2.1
9.	C-2-Butene	1.5
10.	I-Pentane	38.5
11.	N-Pentane	24.1
12.	2,3-Dimethylbutane	2.4
13.	2-Methylpentane	10.4
14.	3-Methylpentane	7.3
15.	N-Hexane	10.8
16.	Methylcyclopentane	7.6
17.	2,4-Dimethylpentane	3.9
18.	Benzene	7.6
19.	2-Methylhexane	15.1
20.	3-Methylhexane	12.3
21.	2,2,4-Trimethylpentane	2.8
22.	N-Heptane	14.3
23.	Ethylcyclopentane	5.3
24.	2,4-Dimethylhexane	1.2
25.	Toluene	78.8
26.	2-Methylheptane	2.4
27.	3-Methylheptane	3.2
28.	N-Octane	3.3
29.	Ethylbenzene	4.2
30.	M+P-Xylene	14.8
31.	O-Xylene	5.0
32.	N-Propylbenzene	1.5
33.	P-Ethyltoluene	4.3
34.	1,3,5-Trimethylbenzene	7.8
35.	O-Ethyltoluene	0.7
36.	1,2,4-Trimethylbenzene	9.6
	Identified NMOC	428
	Unidentified NMOC	212
	Total NMOC	640

OHIO EPA, 1981

Sample I.D. University Campus Site 9/4/81

	Hydrocarbon	ppb
1.	Ethane	13.1
2.	Ethylene	46.2
3.	Acetylene	16.9
4.	Propane	9.8
5.	Propene	11.2
6.	I-Butane	9.1
7.	N-Butane	28.0
8.	T-2-Butene	1.9
9.	C-2-Butene	1.3
10.	I-Pentane	34.4
11.	N-Pentane	18.0
12.	2,3-Dimethylbutane	2.7
13.	2-Methylpentane	11.1
14.	3-Methylpentane	7.4
15.	N-Hexane	8.2
16.	Methylcyclopentane	6.9
17.	2,4-Dimethylpentane	1.7
18.	Benzene	12.3
19.	2-Methylhexane	2.6
20.	3-Methylhexane	4.7
21.	2,2,4-Trimethylpentane	1.0
22.	N-Heptane	7.3
23.	Ethylcyclopentane	2.5
24.	2,4-Dimethylhexane	1.0
25.	Toluene	28.0
26.	2-Methylheptane	3.6
27.	3-Methylheptane	3.2
28.	N-Octane	3.0
29.	Ethylbenzene	5.7
30.	M+P-Xylene	21.8
31.	O-Xylene	1.5
32.	N-Propylbenzene	2.1
33.	P-Ethyltoluene	6.0
34.	1,3,5-Trimethylbenzene	11.0
35.	O-Ethyltoluene	3.0
36.	1,2,4-Trimethylbenzene	12.8
	Identified NMOC	365
	Unidentified NMOC	245
	Total NMOC	610

OHIO EPA, 1981

Sample I.D. Rickoff Site 9/4/81

	Hydrocarbon	ppb
1.	Ethane	10.9
2.	Ethylene	6.4
3.	Acetylene	5.3
4.	Propane	7.0
5.	Propene	2.7
6.	I-Butane	5.6
7.	N-Butane	9.9
8.	T-2-Butene	—
9.	C-2-Butene	—
10.	I-Pentane	11.0
11.	N-Pentane	5.5
12.	2,3-Dimethylbutane	1.3
13.	2-Methylpentane	.39
14.	3-Methylpentane	2.4
15.	N-Hexane	2.8
16.	Methylcyclopentane	3.3
17.	2,4-Dimethylpentane	0.8
18.	Benzene	4.6
19.	2-Methylhexane	2.8
20.	3-Methylhexane	1.7
21.	2,2,4-Trimethylpentane	1.3
22.	N-Heptane	5.3
23.	Ethylcyclopentane	0.9
24.	2,4-Dimethylhexane	—
25.	Toluene	8.4
26.	2-Methylheptane	4.7
27.	3-Methylheptane	1.0
28.	N-Octane	1.9
29.	Ethylbenzene	1.9
30.	M+P-Xylene	6.1
31.	O-Xylene	3.2
32.	N-Propylbenzene	1.2
33.	P-Ethyltoluene	4.6
34.	1,3,5-Trimethylbenzene	4.8
35.	O-Ethyltoluene	3.2
36.	1,2,4-Trimethylbenzene	12.5
	Identified NMOC	149
	Unidentified NMOC	111
	Total NMOC	260

OHIO EPA, 1981

Sample I.D. Rickoff Site 9/6/81

	Hydrocarbon	ppb
1.	Ethane	19.4
2.	Ethylene	9.5
3.	Acetylene	2.5
4.	Propane	10.5
5.	Propene	15.8
6.	I-Butane	9.7
7.	N-Butane	17.7
8.	T-2-Butene	—
9.	C-2-Butene	—
10.	I-Pentane	19.3
11.	N-Pentane	8.7
12.	2,3-Dimethylbutane	1.7
13.	2-Methylpentane	5.6
14.	3-Methylpentane	3.8
15.	N-Hexane	3.4
16.	Methylcyclopentane	3.2
17.	2,4-Dimethylpentane	1.9
18.	Benzene	4.3
19.	2-Methylhexane	3.8
20.	3-Methylhexane	2.5
21.	2,2,4-Trimethylpentane	0.7
22.	N-Heptane	3.7
23.	Ethylcyclopentane	1.4
24.	2,4-Dimethylhexane	—
25.	Toluene	10.2
26.	2-Methylheptane	1.4
27.	3-Methylheptane	1.2
28.	N-Octane	1.5
29.	Ethylbenzene	2.1
30.	M+P-Xylene	9.0
31.	O-Xylene	3.9
32.	N-Propylbenzene	0.8
33.	P-Ethyltoluene	3.5
34.	1,3,5-Trimethylbenzene	8.2
35.	O-Ethyltoluene	2.2
36.	1,2,4-Trimethylbenzene	9.4
	Identified NMOC	207
	Unidentified NMOC	183
	Total NMOC	390

OHIO EPA, 1981

Sample I.D. St. Vincent Site 9/6/81

	Hydrocarbon	ppb
1.	Ethane	12.8
2.	Ethylene	12.5
3.	Acetylene	10.0
4.	Propane	10.0
5.	Propene	12.3
6.	I-Butane	8.5
7.	N-Butane	17.9
8.	T-2-Butene	—
9.	C-2-Butene	—
10.	I-Pentane	16.2
11.	N-Pentane	6.9
12.	2,3-Dimethylbutane	1.3
13.	2-Methylpentane	4.4
14.	3-Methylpentane	3.0
15.	N-Hexane	3.4
16.	Methylcyclopentane	4.4
17.	2,4-Dimethylpentane	1.0
18.	Benzene	5.6
19.	2-Methylhexane	2.4
20.	3-Methylhexane	1.6
21.	2,2,4-Trimethylpentane	1.2
22.	N-Heptane	6.6
23.	Ethylcyclopentane	0.9
24.	2,4-Dimethylhexane	0.8
25.	Toluene	9.6
26.	2-Methylheptane	2.0
27.	3-Methylheptane	0.9
28.	N-Octane	1.9
29.	Ethylbenzene	2.2
30.	M+P-Xylene	9.0
31.	O-Xylene	2.5
32.	N-Propylbenzene	1.3
33.	P-Ethyltoluene	3.6
34.	1,3,5-Trimethylbenzene	9.6
35.	O-Ethyltoluene	1.0
36.	1,2,4-Trimethylbenzene	11.1
	Identified NMOC	200
	Unidentified NMOC	300
	Total NMOC	500

OHIO EPA, 1981

Sample I.D. Norwood Site 9/8/81

	Hydrocarbon	ppb
1.	Ethane	7.5
2.	Ethylene	11.4
3.	Acetylene	9.3
4.	Propane	4.2
5.	Propene	3.4
6.	I-Butane	11.2
7.	N-Butane	31.5
8.	T-2-Butene	–
9.	C-2-Butene	–
10.	I-Pentane	40.5
11.	N-Pentane	28.6
12.	2,3-Dimethylbutane	1.7
13.	2-Methylpentane	2.9
14.	3-Methylpentane	5.9
15.	N-Hexane	10.5
16.	Methylcyclopentane	7.1
17.	2,4-Dimethylpentane	2.0
18.	Benzene	7.9
19.	2-Methylhexane	15.2
20.	3-Methylhexane	12.3
21.	2,2,4-Trimethylpentane	1.3
22.	N-Heptane	14.3
23.	Ethylcyclopentane	5.9
24.	2,4-Dimethylhexane	0.7
25.	Toluene	66.1
26.	2-Methylheptane	2.4
27.	3-Methylheptane	3.4
28.	N-Octane	2.9
29.	Ethylbenzene	5.7
30.	M+P-Xylene	20.7
31.	O-Xylene	6.3
32.	N-Propylbenzene	0.6
33.	P-Ethyltoluene	3.3
34.	1,3,5-Trimethylbenzene	4.6
35.	O-Ethyltoluene	2.4
36.	1,2,4-Trimethylbenzene	6.1
	Identified NMOC	368
	Unidentified NMOC	202
	Total NMOC	570

OHIO EPA, 1981

Sample I.D. University Campus Site 9/8/81

	Hydrocarbon	ppb
1.	Ethane	10.1
2.	Ethylene	20.1
3.	Acetylene	8.6
4.	Propane	1.0
5.	Propene	2.3
6.	I-Butane	5.3
7.	N-Butane	12.4
8.	T-2-Butene	0.8
9.	C-2-Butene	—
10.	I-Pentane	12.4
11.	N-Pentane	7.3
12.	2,3-Dimethylbutane	1.0
13.	2-Methylpentane	4.3
14.	3-Methylpentane	3.1
15.	N-Hexane	3.3
16.	Methylcyclopentane	3.3
17.	2,4-Dimethylpentane	0.7
18.	Benzene	5.4
19.	2-Methylhexane	3.1
20.	3-Methylhexane	1.8
21.	2,2,4-Trimethylpentane	0.7
22.	N-Heptane	4.4
23.	Ethylcyclopentane	1.0
24.	2,4-Dimethylhexane	—
25.	Toluene	13.2
26.	2-Methylheptane	1.5
27.	3-Methylheptane	1.5
28.	N-Octane	1.8
29.	Ethylbenzene	2.9
30.	M+P-Xylene	11.9
31.	O-Xylene	3.8
32.	N-Propylbenzene	1.6
33.	P-Ethyltoluene	3.7
34.	1,3,5-Trimethylbenzene	7.3
35.	O-Ethyltoluene	2.4
36.	1,2,4-Trimethylbenzene	10.2
	Identified NMOC	161
	Unidentified NMOC	169
	Total NMOC	330

OHIO EPA, 1981

Sample I.D. University Campus Site 9/9/81

	Hydrocarbon	ppb
1.	Ethane	15.9
2.	Ethylene	46.1
3.	Acetylene	17.3
4.	Propane	15.1
5.	Propene	10.5
6.	I-Butane	14.3
7.	N-Butane	32.2
8.	T-2-Butene	2.0
9.	C-2-Butene	1.8
10.	I-Pentane	40.5
11.	N-Pentane	21.5
12.	2,3-Dimethylbutane	2.9
13.	2-Methylpentane	11.3
14.	3-Methylpentane	7.6
15.	N-Hexane	8.5
16.	Methylcyclopentane	7.5
17.	2,4-Dimethylpentane	2.2
18.	Benzene	13.2
19.	2-Methylhexane	8.1
20.	3-Methylhexane	4.6
21.	2,2,4-Trimethylpentane	1.7
22.	N-Heptane	6.1
23.	Ethylcyclopentane	2.3
24.	2,4-Dimethylhexane	1.1
25.	Toluene	30.0
26.	2-Methylheptane	2.3
27.	3-Methylheptane	3.0
28.	N-Octane	2.8
29.	Ethylbenzene	5.5
30.	M+P-Xylene	21.2
31.	O-Xylene	7.3
32.	N-Propylbenzene	1.7
33.	P-Ethyltoluene	5.3
34.	1,3,5-Trimethylbenzene	4.7
35.	O-Ethyltoluene	4.8
36.	1,2,4-Trimethylbenzene	10.4
	Identified NMOC	394
	Unidentified NMOC	236
	Total NMOC	630

OHIO EPA, 1981

Sample I.D. Norwood Site 9/10/81

	Hydrocarbon	ppb
1.	Ethane	15.2
2.	Ethylene	33.2
3.	Acetylene	21.2
4.	Propane	29.6
5.	Propene	13.1
6.	I-Butane	17.1
7.	N-Butane	40.4
8.	T-2-Butene	—
9.	C-2-Butene	—
10.	I-Pentane	56.8
11.	N-Pentane	30.5
12.	2,3-Dimethylbutane	4.4
13.	2-Methylpentane	16.6
14.	3-Methylpentane	11.6
15.	N-Hexane	15.5
16.	Methylcyclopentane	8.8
17.	2,4-Dimethylpentane	6.2
18.	Benzene	21.3
19.	2-Methylhexane	12.2
20.	3-Methylhexane	7.8
21.	2,2,4-Trimethylpentane	1.8
22.	N-Heptane	11.0
23.	Ethylcyclopentane	4.3
24.	2,4-Dimethylhexane	1.2
25.	Toluene	65.7
26.	2-Methylheptane	3.5
27.	3-Methylheptane	5.5
28.	N-Octane	5.8
29.	Ethylbenzene	6.2
30.	M+P-Xylene	23.0
31.	O-Xylene	7.8
32.	N-Propylbenzene	1.9
33.	P-Ethyltoluene	5.6
34.	1,3,5-Trimethylbenzene	—
35.	O-Ethyltoluene	2.2
36.	1,2,4-Trimethylbenzene	11.0
	Identified NMOC	519
	Unidentified NMOC	261
	Total NMOC	780

OHIO EPA, 1981

Sample I.D. University Campus Site 9/10/81

	Hydrocarbon	ppb
1.	Ethane	21.3
2.	Ethylene	79.5
3.	Acetylene	37.2
4.	Propane	15.5
5.	Propene	22.7
6.	I-Butane	19.4
7.	N-Butane	58.4
8.	T-2-Butene	5.3
9.	C-2-Butene	3.3
10.	I-Pentane	74.3
11.	N-Pentane	39.7
12.	2,3-Dimethylbutane	5.6
13.	2-Methylpentane	22.9
14.	3-Methylpentane	14.9
15.	N-Hexane	16.0
16.	Methylcyclopentane	11.5
17.	2,4-Dimethylpentane	3.9
18.	Benzene	24.0
19.	2-Methylhexane	16.8
20.	3-Methylhexane	9.8
21.	2,2,4-Trimethylpentane	3.0
22.	N-Heptane	11.8
23.	Ethylcyclopentane	4.9
24.	2,4-Dimethylhexane	2.1
25.	Toluene	55.3
26.	2-Methylheptane	4.5
27.	3-Methylheptane	6.8
28.	N-Octane	5.1
29.	Ethylbenzene	8.4
30.	M+P-Xylene	31.2
31.	O-Xylene	10.8
32.	N-Propylbenzene	2.5
33.	P-Ethyltoluene	7.7
34.	1,3,5-Trimethylbenzene	9.0
35.	O-Ethyltoluene	4.1
36.	1,2,4-Trimethylbenzene	12.5
	Identified NMOC	682
	Unidentified NMOC	228
	Total NMOC	910

OHIO EPA, 1981

Sample I.D. Norwood Site 9/11/81

	Hydrocarbon	ppb
1.	Ethane	21.6
2.	Ethylene	47.5
3.	Acetylene	35.2
4.	Propane	29.6
5.	Propene	19.4
6.	I-Butane	21.5
7.	N-Butane	52.0
8.	T-2-Butene	4.4
9.	C-2-Butene	3.0
10.	I-Pentane	69.9
11.	N-Pentane	40.3
12.	2,3-Dimethylbutane	5.3
13.	2-Methylpentane	22.0
14.	3-Methylpentane	15.3
15.	N-Hexane	23.4
16.	Methylcyclopentane	12.2
17.	2,4-Dimethylpentane	3.7
18.	Benzene	20.7
19.	2-Methylhexane	10.1
20.	3-Methylhexane	13.8
21.	2,2,4-Trimethylpentane	4.9
22.	N-Heptane	16.9
23.	Ethylcyclopentane	8.4
24.	2,4-Dimethylhexane	2.3
25.	Toluene	159.0
26.	2-Methylheptane	4.2
27.	3-Methylheptane	6.5
28.	N-Octane	5.5
29.	Ethylbenzene	6.1
30.	M+P-Xylene	33.7
31.	O-Xylene	11.3
32.	N-Propylbenzene	2.5
33.	P-Ethyltoluene	7.1
34.	1,3,5-Trimethylbenzene	33.4
35.	O-Ethyltoluene	9.3
36.	1,2,4-Trimethylbenzene	13.6
	Identified NMOC	804
	Unidentified NMOC	296
	Total NMOC	1100

OHIO EPA, 1981

Sample I.D. Rickoff Site 9/11/81

	Hydrocarbon	ppb
1.	Ethane	10.5
2.	Ethylene	13.4
3.	Acetylene	9.3
4.	Propane	14.2
5.	Propene	5.3
6.	I-Butane	4.8
7.	N-Butane	20.5
8.	T-2-Butene	0.9
9.	C-2-Butene	—
10.	I-Pentane	25.0
11.	N-Pentane	8.2
12.	2,3-Dimethylbutane	2.1
13.	2-Methylpentane	8.0
14.	3-Methylpentane	4.8
15.	N-Hexane	5.2
16.	Methylcyclopentane	4.6
17.	2,4-Dimethylpentane	1.3
18.	Benzene	4.4
19.	2-Methylhexane	5.2
20.	3-Methylhexane	3.0
21.	2,2,4-Trimethylpentane	1.0
22.	N-Heptane	5.5
23.	Ethylcyclopentane	1.7
24.	2,4-Dimethylhexane	0.6
25.	Toluene	17.4
26.	2-Methylheptane	1.5
27.	3-Methylheptane	1.6
28.	N-Octane	1.8
29.	Ethylbenzene	3.1
30.	M+P-Xylene	13.2
31.	O-Xylene	4.5
32.	N-Propylbenzene	1.1
33.	P-Ethyltoluene	4.3
34.	1,3,5-Trimethylbenzene	33.9
35.	O-Ethyltoluene	2.1
36.	1,2,4-Trimethylbenzene	9.1
	Identified NMOC	258
	Unidentified NMOC	182
	Total NMOC	440

OHIO EPA, 1981

Sample I.D. St Vincent Site 9/11/81

	Hydrocarbon	ppb
1.	Ethane	28.3
2.	Ethylene	34.2
3.	Acetylene	18.1
4.	Propane	116.8
5.	Propene	24.7
6.	I-Butane	203.7
7.	N-Butane	305.3
8.	T-2-Butene	6.6
9.	C-2-Butene	5.2
10.	I-Pentane	255.2
11.	N-Pentane	62.7
12.	2,3-Dimethylbutane	10.3
13.	2-Methylpentane	62.9
14.	3-Methylpentane	30.5
15.	N-Hexane	26.5
16.	Methylcyclopentane	22.4
17.	2,4-Dimethylpentane	7.5
18.	Benzene	26.4
19.	2-Methylhexane	33.3
20.	3-Methylhexane	22.8
21.	2,2,4-Trimethylpentane	6.4
22.	N-Heptane	15.9
23.	Ethylcyclopentane	8.3
24.	2,4-Dimethylhexane	3.3
25.	Toluene	69.4
26.	2-Methylheptane	5.5
27.	3-Methylheptane	7.9
28.	N-Octane	4.9
29.	Ethylbenzene	8.6
30.	M+P-Xylene	29.6
31.	O-Xylene	9.8
32.	N-Propylbenzene	2.1
33.	P-Ethyltoluene	6.7
34.	1,3,5-Trimethylbenzene	13.1
35.	O-Ethyltoluene	3.3
36.	1,2,4-Trimethylbenzene	13.2
	Identified NMOC	1503
	Unidentified NMOC	367
	Total NMOC	1870

OHIO EPA, 1981

Sample I.D. Norwood Site 9/12/81

	Hydrocarbon	ppb
1.	Ethane	17.8
2.	Ethylene	23.7
3.	Acetylene	17.1
4.	Propane	30.9
5.	Propene	9.6
6.	I-Butane	15.1
7.	N-Butane	41.3
8.	T-2-Butene	2.8
9.	C-2-Butene	1.9
10.	I-Pentane	54.0
11.	N-Pentane	30.0
12.	2,3-Dimethylbutane	4.5
13.	2-Methylpentane	15.0
14.	3-Methylpentane	9.9
15.	N-Hexane	11.3
16.	Methylcyclopentane	12.3
17.	2,4-Dimethylpentane	2.7
18.	Benzene	12.5
19.	2-Methylhexane	11.2
20.	3-Methylhexane	2.5
21.	2,2,4-Trimethylpentane	2.0
22.	N-Heptane	2.7
23.	Ethylcyclopentane	4.4
24.	2,4-Dimethylhexane	0.6
25.	Toluene	56.9
26.	2-Methylheptane	2.3
27.	3-Methylheptane	4.7
28.	N-Octane	5.3
29.	Ethylbenzene	5.7
30.	M+P-Xylene	19.8
31.	O-Xylene	7.0
32.	N-Propylbenzene	1.5
33.	P-Ethyltoluene	5.4
34.	1,3,5-Trimethylbenzene	12.3
35.	O-Ethyltoluene	4.8
36.	1,2,4-Trimethylbenzene	11.4
	Identified NMOC	498
	Unidentified NMOC	277
	Total NMOC	775

OHIO EPA, 1981

Sample I.D. Norwood Site 9/2/81 Repeat Analysis

	Hydrocarbon	ppb
1.	Ethane	18.7
2.	Ethylene	24.0
3.	Acetylene	18.2
4.	Propane	32.0
5.	Propene	10.2
6.	I-Butane	16.2
7.	N-Butane	41.7
8.	T-2-Butene	2.5
9.	C-2-Butene	2.0
10.	I-Pentane	52.5
11.	N-Pentane	29.6
12.	2,3-Dimethylbutane	4.2
13.	2-Methylpentane	14.3
14.	3-Methylpentane	9.8
15.	N-Hexane	10.8
16.	Methylcyclopentane	12.3
17.	2,4-Dimethylpentane	10.5
18.	Benzene	12.0
19.	2-Methylhexane	11.8
20.	3-Methylhexane	7.5
21.	2,2,4-Trimethylpentane	1.6
22.	N-Heptane	9.1
23.	Ethylcyclopentane	4.4
24.	2,4-Dimethylhexane	1.4
25.	Toluene	54.7
26.	2-Methylheptane	3.5
27.	3-Methylheptane	4.8
28.	N-Octane	5.6
29.	Ethylbenzene	5.3
30.	M+P-Xylene	19.3
31.	O-Xylene	7.0
32.	N-Propylbenzene	1.8
33.	P-Ethyltoluene	5.4
34.	1,3,5-Trimethylbenzene	5.8
35.	O-Ethyltoluene	4.2
36.	1,2,4-Trimethylbenzene	11.2
	Identified NMOC	487
	Unidentified NMOC	243
	Total NMOC	730

OHIO EPA, 1981

Sample I.D. University Campus Site 9/12/81

	Hydrocarbon	ppb
1.	Ethane	21.6
2.	Ethylene	50.5
3.	Acetylene	22.4
4.	Propane	15.5
5.	Propene	14.3
6.	I-Butane	19.8
7.	N-Butane	49.1
8.	T-2-Butene	3.6
9.	C-2-Butene	2.2
10.	I-Pentane	55.9
11.	N-Pentane	26.1
12.	2,3-Dimethylbutane	4.2
13.	2-Methylpentane	17.2
14.	3-Methylpentane	11.4
15.	N-Hexane	11.8
16.	Methylcyclopentane	9.8
17.	2,4-Dimethylpentane	2.6
18.	Benzene	17.5
19.	2-Methylhexane	11.3
20.	3-Methylhexane	6.8
21.	2,2,4-Trimethylpentane	2.1
22.	N-Heptane	8.0
23.	Ethylcyclopentane	3.3
24.	2,4-Dimethylhexane	1.4
25.	Toluene	40.3
26.	2-Methylheptane	3.4
27.	3-Methylheptane	4.1
28.	N-Octane	4.2
29.	Ethylbenzene	6.8
30.	M+P-Xylene	25.9
31.	O-Xylene	9.3
32.	N-Propylbenzene	2.1
33.	P-Ethyltoluene	2.5
34.	1,3,5-Trimethylbenzene	5.7
35.	O-Ethyltoluene	3.8
36.	1,2,4-Trimethylbenzene	12.5
	Identified NMOC	511
	Unidentified NMOC	249
	Total NMOC	760

OHIO EPA, 1981

Sample I.D. University Campus Site 9/12/81 Repeat Analysis

	Hydrocarbon	ppb
1.	Ethane	21.1
2.	Ethylene	50.8
3.	Acetylene	22.1
4.	Propane	15.2
5.	Propene	15.0
6.	I-Butane	19.1
7.	N-Butane	47.7
8.	T-2-Butene	3.6
9.	C-2-Butene	2.5
10.	I-Pentane	37.5
11.	N-Pentane	29.5
12.	2,3-Dimethylbutane	4.4
13.	2-Methylpentane	16.9
14.	3-Methylpentane	11.0
15.	N-Hexane	11.6
16.	Methylcyclopentane	9.8
17.	2,4-Dimethylpentane	2.8
18.	Benzene	15.6
19.	2-Methylhexane	11.2
20.	3-Methylhexane	6.8
21.	2,2,4-Trimethylpentane	2.0
22.	N-Heptane	8.5
23.	Ethylcyclopentane	3.3
24.	2,4-Dimethylhexane	1.4
25.	Toluene	38.5
26.	2-Methylheptane	3.4
27.	3-Methylheptane	4.1
28.	N-Octane	3.8
29.	Ethylbenzene	6.6
30.	M+P-Xylene	24.5
31.	O-Xylene	8.5
32.	N-Propylbenzene	2.2
33.	P-Ethyltoluene	6.5
34.	1,3,5-Trimethylbenzene	2.9
35.	O-Ethyltoluene	3.1
36.	1,2,4-Trimethylbenzene	12.5
	Identified NMOC	513
	Unidentified NMOC	257
	Total NMOC	770

OHIO EPA, 1981

Sample I.D. St. Vincent Site 9/12/81

	Hydrocarbon	ppb
1.	Ethane	48.2
2.	Ethylene	34.6
3.	Acetylene	22.9
4.	Propane	35.7
5.	Propene	14.6
6.	I-Butane	33.1
7.	N-Butane	74.9
8.	T-2-Butene	2.7
9.	C-2-Butene	1.4
10.	I-Pentane	89.4
11.	N-Pentane	36.6
12.	2,3-Dimethylbutane	5.9
13.	2-Methylpentane	24.3
14.	3-Methylpentane	15.8
15.	N-Hexane	16.2
16.	Methylcyclopentane	12.1
17.	2,4-Dimethylpentane	3.3
18.	Benzene	18.2
19.	2-Methylhexane	14.6
20.	3-Methylhexane	9.4
21.	2,2,4-Trimethylpentane	3.1
22.	N-Heptane	10.8
23.	Ethylcyclopentane	6.6
24.	2,4-Dimethylhexane	1.8
25.	Toluene	38.9
26.	2-Methylheptane	4.0
27.	3-Methylheptane	5.9
28.	N-Octane	4.7
29.	Ethylbenzene	8.5
30.	M+P-Xylene	29.2
31.	O-Xylene	10.7
32.	N-Propylbenzene	3.6
33.	P-Ethyltoluene	7.6
34.	1,3,5-Trimethylbenzene	10.4
35.	O-Ethyltoluene	1.7
36.	1,2,4-Trimethylbenzene	12.4
	Identified NMOC	674
	Unidentified NMOC	246
	Total NMOC	920

OHIO EPA, 1981

Sample I.D. Uscanod Site 9/13/81

	Hydrocarbon	ppb
1.	Ethane	13.7
2.	Ethylene	14.6
3.	Acetylene	29.3
4.	Propane	21.4
5.	Propene	6.7
6.	I-Butane	9.9
7.	N-Butane	24.1
8.	T-2-Butene	1.3
9.	C-2-Butene	0.8
10.	I-Pentane	30.3
11.	N-Pentane	10.1
12.	2,3-Dimethylbutane	2.3
13.	2-Methylpentane	8.2
14.	3-Methylpentane	5.7
15.	N-Hexane	2.4
16.	Methylcyclopentane	4.8
17.	2,4-Dimethylpentane	1.3
18.	Benzene	2.2
19.	2-Methylhexane	5.3
20.	3-Methylhexane	3.5
21.	2,2,4-Trimethylpentane	0.4
22.	N-Heptane	5.2
23.	Ethylcyclopentane	2.0
24.	2,4-Dimethylhexane	0.7
25.	Toluene	23.7
26.	2-Methylheptane	1.5
27.	3-Methylheptane	1.8
28.	N-Octane	3.1
29.	Ethylbenzene	3.2
30.	M+P-Xylene	11.5
31.	O-Xylene	4.0
32.	N-Propylbenzene	1.0
33.	P-Ethyltoluene	2.9
34.	1,3,5-Trimethylbenzene	2.1
35.	O-Ethyltoluene	2.2
36.	1,2,4-Trimethylbenzene	7.3
	Identified NMOC	288
	Unidentified NMOC	132
	Total NMOC	420

OHIO EPA, 1981

Sample I.D. University Campus Site 9/14/81

	Hydrocarbon	ppb
1.	Ethane	22.0
2.	Ethylene	64.4
3.	Acetylene	29.9
4.	Propane	12.8
5.	Propene	18.2
6.	I-Butane	21.3
7.	N-Butane	56.5
8.	T-2-Butene	5.0
9.	C-2-Butene	3.3
10.	I-Pentane	72.5
11.	N-Pentane	37.9
12.	2,3-Dimethylbutane	6.0
13.	2-Methylpentane	26.9
14.	3-Methylpentane	16.5
15.	N-Hexane	19.7
16.	Methylcyclopentane	13.9
17.	2,4-Dimethylpentane	1.8
18.	Benzene	23.4
19.	2-Methylhexane	12.7
20.	3-Methylhexane	11.3
21.	2,2,4-Trimethylpentane	3.5
22.	N-Heptane	10.9
23.	Ethylcyclopentane	5.3
24.	2,4-Dimethylhexane	2.2
25.	Toluene	53.4
26.	2-Methylheptane	4.6
27.	3-Methylheptane	7.0
28.	N-Octane	5.7
29.	Ethylbenzene	4.8
30.	M+P-Xylene	35.8
31.	O-Xylene	12.1
32.	N-Propylbenzene	2.5
33.	P-Ethyltoluene	8.1
34.	1,3,5-Trimethylbenzene	5.4
35.	O-Ethyltoluene	3.8
36.	1,2,4-Trimethylbenzene	13.3
	Identified NMOC	715
	Unidentified NMOC	235
	Total NMOC	950

OHIO EPA, 1981

Sample I.D. Rickoff Site 9/14/81

	Hydrocarbon	ppb
1.	Ethane	17.5
2.	Ethylene	13.1
3.	Acetylene	9.0
4.	Propane	10.2
5.	Propene	1.7
6.	I-Butane	11.0
7.	N-Butane	21.9
8.	T-2-Butene	—
9.	C-2-Butene	—
10.	I-Pentane	24.5
11.	N-Pentane	9.6
12.	2,3-Dimethylbutane	2.1
13.	2-Methylpentane	8.1
14.	3-Methylpentane	5.5
15.	N-Hexane	5.2
16.	Methylcyclopentane	4.8
17.	2,4-Dimethylpentane	2.2
18.	Benzene	6.7
19.	2-Methylhexane	5.1
20.	3-Methylhexane	3.4
21.	2,2,4-Trimethylpentane	0.7
22.	N-Heptane	3.4
23.	Ethylcyclopentane	1.6
24.	2,4-Dimethylhexane	0.7
25.	Toluene	14.7
26.	2-Methylheptane	1.2
27.	3-Methylheptane	1.6
28.	N-Octane	1.6
29.	Ethylbenzene	2.9
30.	M+P-Xylene	11.9
31.	O-Xylene	4.2
32.	N-Propylbenzene	1.1
33.	P-Ethyltoluene	4.5
34.	1,3,5-Trimethylbenzene	5.1
35.	O-Ethyltoluene	3.2
36.	1,2,4-Trimethylbenzene	8.6
	Identified NMOC	229
	Unidentified NMOC	151
	Total NMOC	380

OHIO EPA, 1981

Sample I.D. St. Vincent Site 9/14/81

	Hydrocarbon	ppb
1.	Ethane	22.9
2.	Ethylene	28.0
3.	Acetylene	12.3
4.	Propane	12.1
5.	Propene	12.7
6.	I-Butane	21.1
7.	N-Butane	62.6
8.	T-2-Butene	2.1
9.	C-2-Butene	2.6
10.	I-Pentane	54.3
11.	N-Pentane	23.0
12.	2,3-Dimethylbutane	3.5
13.	2-Methylpentane	13.7
14.	3-Methylpentane	8.9
15.	N-Hexane	8.2
16.	Methylcyclopentane	6.4
17.	2,4-Dimethylpentane	3.7
18.	Benzene	13.5
19.	2-Methylhexane	2.1
20.	3-Methylhexane	5.2
21.	2,2,4-Trimethylpentane	1.4
22.	N-Heptane	5.5
23.	Ethylcyclopentane	2.5
24.	2,4-Dimethylhexane	1.1
25.	Toluene	28.6
26.	2-Methylheptane	2.3
27.	3-Methylheptane	2.5
28.	N-Octane	2.2
29.	Ethylbenzene	5.2
30.	M+P-Xylene	18.9
31.	O-Xylene	6.9
32.	N-Propylbenzene	1.1
33.	P-Ethyltoluene	2.0
34.	1,3,5-Trimethylbenzene	10.0
35.	O-Ethyltoluene	4.6
36.	1,2,4-Trimethylbenzene	16.7
	Identified NMOC	447
	Unidentified NMOC	223
	Total NMOC	670

OHIO EPA, 1981

Sample I.D. St. Vincent Site 9/14/81 Repeat Analysis

	Hydrocarbon	ppb
1.	Ethane	22.8
2.	Ethylene	27.7
3.	Acetylene	18.8
4.	Propane	17.3
5.	Propene	11.6
6.	I-Butane	20.6
7.	N-Butane	61.5
8.	T-2-Butene	2.2
9.	C-2-Butene	1.4
10.	I-Pentane	53.7
11.	N-Pentane	20.5
12.	2,3-Dimethylbutane	3.5
13.	2-Methylpentane	13.3
14.	3-Methylpentane	8.7
15.	N-Hexane	8.0
16.	Methylcyclopentane	6.7
17.	2,4-Dimethylpentane	1.9
18.	Benzene	13.2
19.	2-Methylhexane	7.7
20.	3-Methylhexane	4.8
21.	2,2,4-Trimethylpentane	1.3
22.	N-Heptane	5.6
23.	Ethylcyclopentane	5.4
24.	2,4-Dimethylhexane	1.0
25.	Toluene	23.8
26.	2-Methylheptane	2.2
27.	3-Methylheptane	2.7
28.	N-Octane	2.3
29.	Ethylbenzene	4.9
30.	M+P-Xylene	17.6
31.	O-Xylene	6.4
32.	N-Propylbenzene	1.6
33.	P-Ethyltoluene	5.8
34.	1,3,5-Trimethylbenzene	5.5
35.	O-Ethyltoluene	3.7
36.	1,2,4-Trimethylbenzene	13.0
	Identified NMOC	429
	Unidentified NMOC	231
	Total NMOC	660

OHIO EPA, 1981

Sample I.D. Norwood Site 9/15/81

	Hydrocarbon	ppb
1.	Ethane	16.4
2.	Ethylene	13.2
3.	Acetylene	6.4
4.	Propane	16.4
5.	Propene	4.5
6.	I-Butane	7.8
7.	N-Butane	12.3
8.	T-2-Butene	1.1
9.	C-2-Butene	0.6
10.	I-Pentane	25.3
11.	N-Pentane	16.7
12.	2,3-Dimethylbutane	1.4
13.	2-Methylpentane	6.5
14.	3-Methylpentane	4.7
15.	N-Hexane	5.6
16.	Methylcyclopentane	4.5
17.	2,4-Dimethylpentane	3.2
18.	Benzene	8.1
19.	2-Methylhexane	4.4
20.	3-Methylhexane	3.0
21.	2,2,4-Trimethylpentane	1.2
22.	N-Heptane	1.9
23.	Ethylcyclopentane	2.5
24.	2,4-Dimethylhexane	0.5
25.	Toluene	29.5
26.	2-Methylheptane	1.2
27.	3-Methylheptane	1.6
28.	N-Octane	1.8
29.	Ethylbenzene	2.4
30.	M+P-Xylene	9.9
31.	O-Xylene	3.1
32.	N-Propylbenzene	1.2
33.	P-Ethyltoluene	2.6
34.	1,3,5-Trimethylbenzene	22.1
35.	O-Ethyltoluene	0.7
36.	1,2,4-Trimethylbenzene	5.9
	Identified NMOC	256
	Unidentified NMOC	194
	Total NMOC	450

OHIO EPA, 1981

Sample I.D. University Campus Site 9/15/81

	Hydrocarbon	ppb
1.	Ethane	14.1
2.	Ethylene	29.9
3.	Acetylene	9.9
4.	Propane	12.1
5.	Propene	4.5
6.	I-Butane	10.5
7.	N-Butane	28.2
8.	T-2-Butene	1.3
9.	C-2-Butene	1.0
10.	I-Pentane	29.2
11.	N-Pentane	11.2
12.	2,3-Dimethylbutane	1.7
13.	2-Methylpentane	7.1
14.	3-Methylpentane	4.9
15.	N-Hexane	5.9
16.	Methylcyclopentane	5.0
17.	2,4-Dimethylpentane	1.8
18.	Benzene	8.4
19.	2-Methylhexane	4.0
20.	3-Methylhexane	2.7
21.	2,2,4-Trimethylpentane	0.6
22.	N-Heptane	4.3
23.	Ethylcyclopentane	1.6
24.	2,4-Dimethylhexane	0.6
25.	Toluene	22.8
26.	2-Methylheptane	1.5
27.	3-Methylheptane	1.8
28.	N-Octane	1.8
29.	Ethylbenzene	3.5
30.	M+P-Xylene	13.7
31.	O-Xylene	4.3
32.	N-Propylbenzene	0.8
33.	P-Ethyltoluene	3.3
34.	1,3,5-Trimethylbenzene	14.9
35.	O-Ethyltoluene	4.8
36.	1,2,4-Trimethylbenzene	8.6
	Identified NMOC	280
	Unidentified NMOC	135
	Total NMOC	415

OHIO EPA, 1981

Sample I.D. Rickoff Site 9/15/81

	Hydrocarbon	ppb
1.	Ethane	13.9
2.	Ethylene	19.0
3.	Acetylene	12.6
4.	Propane	6.7
5.	Propene	2.3
6.	I-Butane	7.6
7.	N-Butane	12.5
8.	T-2-Butene	—
9.	C-2-Butene	4.8
10.	I-Pentane	25.8
11.	N-Pentane	11.6
12.	2,3-Dimethylbutane	2.3
13.	2-Methylpentane	9.7
14.	3-Methylpentane	6.4
15.	N-Hexane	6.7
16.	Methylcyclopentane	4.8
17.	2,4-Dimethylpentane	—
18.	Benzene	10.2
19.	2-Methylhexane	2.7
20.	3-Methylhexane	5.9
21.	2,2,4-Trimethylpentane	1.5
22.	N-Heptane	6.6
23.	Ethylcyclopentane	2.4
24.	2,4-Dimethylhexane	0.5
25.	Toluene	27.4
26.	2-Methylheptane	0.8
27.	3-Methylheptane	2.3
28.	N-Octane	1.5
29.	Ethylbenzene	3.7
30.	M+P-Xylene	14.8
31.	O-Xylene	5.5
32.	N-Propylbenzene	1.1
33.	P-Ethyltoluene	4.5
34.	1,3,5-Trimethylbenzene	5.6
35.	O-Ethyltoluene	2.0
36.	1,2,4-Trimethylbenzene	8.0
	Identified NMOC	265
	Unidentified NMOC	145
	Total NMOC	410

OHIO EPA, 1981

Sample I.D. Rickoff Site 9/15/81 Repeat Analysis

	Hydrocarbon	ppb
1.	Ethane	13.5
2.	Ethylene	16.3
3.	Acetylene	11.5
4.	Propane	6.2
5.	Propene	7.2
6.	I-Butane	7.6
7.	N-Butane	17.1
8.	T-2-Butene	1.2
9.	C-2-Butene	0.7
10.	I-Pentane	25.1
11.	N-Pentane	9.2
12.	2,3-Dimethylbutane	2.0
13.	2-Methylpentane	8.6
14.	3-Methylpentane	5.8
15.	N-Hexane	6.3
16.	Methylcyclopentane	4.9
17.	2,4-Dimethylpentane	1.3
18.	Benzene	8.9
19.	2-Methylhexane	7.2
20.	3-Methylhexane	5.4
21.	2,2,4-Trimethylpentane	1.4
22.	N-Heptane	6.2
23.	Ethylcyclopentane	2.1
24.	2,4-Dimethylhexane	0.8
25.	Toluene	25.2
26.	2-Methylheptane	1.7
27.	3-Methylheptane	2.1
28.	N-Octane	1.6
29.	Ethylbenzene	3.4
30.	M+P-Xylene	13.4
31.	O-Xylene	4.9
32.	N-Propylbenzene	1.2
33.	P-Ethyltoluene	4.0
34.	1,3,5-Trimethylbenzene	4.6
35.	O-Ethyltoluene	1.8
36.	1,2,4-Trimethylbenzene	8.0
	Identified NMOC	248
	Unidentified NMOC	162
	Total NMOC	410

OHIO EPA, 1981

Sample I.D. St. Vincent Site 9/15/81

	Hydrocarbon	ppb
1.	Ethane	239
2.	Ethylene	25.8
3.	Acetylene	16.3
4.	Propane	13.5
5.	Propene	5.7
6.	I-Butane	17.4
7.	N-Butane	38.2
8.	T-2-Butene	1.8
9.	C-2-Butene	1.1
10.	I-Pentane	47.4
11.	N-Pentane	19.3
12.	2,3-Dimethylbutane	3.6
13.	2-Methylpentane	14.2
14.	3-Methylpentane	8.6
15.	N-Hexane	8.6
16.	Methylcyclopentane	8.1
17.	2,4-Dimethylpentane	4.3
18.	Benzene	12.0
19.	2-Methylhexane	8.4
20.	3-Methylhexane	5.6
21.	2,2,4-Trimethylpentane	1.8
22.	N-Heptane	5.5
23.	Ethylcyclopentane	2.8
24.	2,4-Dimethylhexane	1.1
25.	Toluene	29.1
26.	2-Methylheptane	2.6
27.	3-Methylheptane	3.8
28.	N-Octane	2.5
29.	Ethylbenzene	4.3
30.	M+P-Xylene	16.9
31.	O-Xylene	5.7
32.	N-Propylbenzene	1.2
33.	P-Ethyltoluene	4.4
34.	1,3,5-Trimethylbenzene	0.4
35.	O-Ethyltoluene	2.5
36.	1,2,4-Trimethylbenzene	9.3
	Identified NMOC	382
	Unidentified NMOC	173
	Total NMOC	555

APPENDIX B

GAS CHROMATOGRAPHIC AUDIT BETWEEN BATTELLE AND THE GKPB BRANCH OF EPA

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

DATE: December 10, 1981

SUBJECT: Results of the G.C. Audit Between Battelle and the GKPB for two QC Hydrocarbon Mixtures

FROM: William Lonneman, GKPB, MD-84

TO: Hal Richter, OAQPS, MD-14

Battelle was asked to participate in a g.c. audit program coordinated by EPA laboratories at RTP. The purpose of this audit program was to compare all environmental laboratories making detailed hydrocarbon analysis of ambient air to a central laboratory. Presently this central laboratory is the Gas Kinetics and Photochemistry Branch (GKPB). Battelle performed detailed hydrocarbon analysis of ambient air in several Ohio sites during the summer months of 1981 for the Ohio EPA.

The general procedure used in previous QC programs was also used for this audit. Two treated stainless steel cylinders were filled with prepared QC hydrocarbon mixtures, analyzed and sent to Battelle. After Battelle completed their analysis of the cylinders they were returned to RTP for repeat analysis to determine any storage loss of the hydrocarbon components. The GKPB used the mobile laboratory procedures to determine initial HC component concentrations in the sample canisters. Upon return of the cylinders from Battelle, the GKPB used two different g.c. procedures to analyze the hydrocarbon mixtures. The second procedure, identified in Tables 1 and 2 as GKPB^2, consisted of a fused silica capillary column approach developed for the 1981 Atlanta Field Study program. This procedure is quite similar to that used by Battelle.

From Tables 1 and 2 one can observe rather good agreement between the two Laboratories. This is particularly true for the C_2-C_5 hydrocarbon components where with the exception of n-butane in mixture 3 the results for all laboratories analysis agreed to within $\pm$ 15%. Similar comparabilities are observed for several of the C_6 and higher compounds, however, some in some instances the range of analysis results were $\pm$ 25% e.g. 1, 3, 5 trimethyl benzene in QC mixture 3 and p-ethyltoluene in QC mixture 4. Largest discrepancies are generally observed for the heavier M.W. compounds and perhaps are indicative of sample storage and handling problems. Another possible problem area involves the g.c. computer system sensitivities selection. In the case of the GKPB mobile laboratory procedure, the heavier M.W. compounds are broader peaks than the light M.W. compounds. Care must be taken to select the sensitivity parameters that

accurately measure both broad and sharp peaks. Broad peaks such as 1, 3, 5 Trimethylbenzene and 2 and 3 methylhexane can present some problems. It is curious to note the general better comparability between the GKPB capillary system (GKPB[2]) and the Battelle results. Since both systems are similar temperature programmed capillary column procedures, one could expect better agreement especially for data computer systems. Table 1 and 2 results indicate that different g.c. systems may provide different analyses. This, however, has not been the general experience in past QC programs.

It should also be pointed out that all of the C_2-C_9 hydrocarbon stored very well in the two D & S stainless steel containers over the three week period. No significant loss of any component except perhaps p-Ethyl toluene QC mixture 4 (Table 2), was observed. This has not always been the case in past QC programs.

Attachments

Table 1. QC Mixture 3 Results for Battelle-Columbus and the GKPB, D&S Can #26

Compound	GKPB Oct. 9	Battelle Oct. 16	GKPB Oct. 25	GKPB[2] Oct. 28
Ethane	17.5	18.1	17.0	--
Ethylene	3.4	3.0	--	--
Propylene	19.9	17.2	20.9	--
Isobutane	20.7	21.1	19.4	21.1
n-Butane	16.3	16.8	17.0	16.7
Isobutylene	20.5	23.0	20.4	22.3
t-Butene-2	6.3	6.6	8.8	6.5
n-Hexane	16.8	19.0	15.8	19.5
2,4 Dimethylpentane	17.3	20.2	17.2	20.6
Cyclohexane	22.5	23.9	20.4	24.4
3-methylhexane	15.4	18.7	14.4	19.0
Toluene	20.6	23.7	20.6	23.3
m-Xylene	18.1	23.2	18.7	22.9
1,3,5 Trimethyl-benzene	15.8	21.5	--	18.9

GKPB[1] is the results obtained with the three column g.c. system located in the mobile laboratory.

GKPB[2] is the results obtained from the Fused Silica capillary column procedure located in EPA Tech Center.

Table 2. QC Mixture 4 Results for Battelle-Columbus and the GKPB, D & S Can #17

Compound	GKPB[1] Oct. 9	Battelle Oct. 16	GKPB[1] Oct. 25	GKPB[2] Oct. 28
Ethane	13.3	13.8	--	--
Ethylene	13.3	12.0	13.2	--
Propane	14.3	15.4	--	--
n-Butane	8.5	9.1	8.5	9.7
t-Butene-2	2.4	2.6	2.4	2.5
C-Butene-2	7.1	7.7	7.2	7.5
2 Methylbutene-1	14.1	16.2	13.5	15.5
2 Methylbutene-2	13.3	14.4	12.4	12.7
2 Methylhexane	11.6	13.3	15.2	13.8
Cyclopentane	12.9	14.9	13.0	15.3
2,3 Dimethylbutane	10.1	11.9	10.0	12.2
Benzene	13.1	15.0	13.4	14.9
Toleuen	12.5	14.3	12.4	14.1
p-Xylene	10.9	13.3	10.6	12.1
p-Ethyltoluene	11.3	10.0	6.6	7.6
o-Ethyltoluene	9.0	10.7	11.5	9.2
Isopropylbenzene	10.1	13.1	10.2	11.7

GKPB[1] is the results obtained with the three column gc system located in the mobile laboratory.

GKPB[2] is the results obtained from the fused silica capillary column procedure located in the EPA tech center.